The Engineer.

MAY 15 1929

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLVII.—No. 3825] LONDON: FRIDAY EVENING, MAY 3, 1929 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for—

SCHEDULE 1. — STEEL FLUE and BOILER TUBES for LOCOMOTIVES.

SCHEDULE 2.—BUFFERS, WHEELS and AXLES, and other DUPLICATE PARTS for LOCOMOTIVES.

Tenders due on 28th May, 1929.

Forms of Tender available from the above at a fee (which will not be returned) of 5s. for each schedule. 1814

Civil Service Commission.

FORTHCOMING EXAMINATION.—ASSISTANT EXAMINERS in the Patent Office (20-25, with extension in certain cases).

Regulations and particulars, together with the forms on which applications must be made, will be sent in response to requests (preferably by postcard), addressed to the SECRETARY, Civil Service Commission, Burlington-gardens, London, W. 1. The latest date for the receipt of application forms is 6th June. 1550

Crown Agents for the Colonies.

COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/1509.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of HONG KONG PUBLIC WORKS DEPARTMENT, for three years' service, with possible permanency. Salary £460, rising to £500 a year by annual increments of £20, and thereafter, if the appointment becomes permanent, rising by annual increments to a maximum of £1000 a year, payable in dollars under the compensation scheme at present in force at a favourable rate of exchange. Free first-class passages provided. Candidates, 22 to 28 years of age, single, must have passed examinations for Sections "A" and "B" of the A.M.I.C.E. Diploma or hold professional qualifications accepted by the Institution of Civil Engineers as exempting from those examinations. Must be able to carry out Surveys, make all the plans necessary for the Preparation of Detailed Design, and Prepare Bills of Quantities for the letting of work on contract in connection with Road Construction, including Bridge Work in Reinforced Concrete and the Construction of Buildings. Candidates must be able to ride a motor bicycle.

M/1502.—ASSISTANT ENGINEER REQUIRED for the PUBLIC WORKS DEPARTMENT of the STRAITS SETTLEMENTS, for four years' service, after which, subject to satisfactory service, the officers appointed will be eligible for confirmation in the permanent and pensionable establishment. It is probable that the number of permanent appointments will be sufficient for those officers whose services have been entirely satisfactory, but no guarantee can be given. If at the end of four years' service an officer's services have been entirely satisfactory, and he is not offered or declines further employment, he will be paid a bonus of 2850 dollars. Salary 400 dollars a month, rising to 800 dollars by annual increments of 25 dollars, plus a temporary non-pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No Income Tax at present imposed by the Straits Settlements Government. Free passages provided. Candidates, age 23 to 26, must have received a good theoretical training, preferably at a University or College recognised by the Institution of Civil Engineers and possess a Civil Engineering Degree or obtain such other Diploma or Distinction in Engineering as the Secretary of State may decide in any particular case, or have completed articles with a Civil Engineer of good standing, and have passed the Examination for Associate Membership of the Institution of Civil Engineers. In addition, candidates must have had at least one year's practical experience of Civil Engineering under a qualified Civil Engineer.

M/1476.—FACTORIES INSPECTOR REQUIRED by the GOVERNMENT of UGANDA for the PUBLIC WORKS DEPARTMENT, for a tour of 20 to 30 months' service in the first instance, with a possibility of permanency. Salary, £600-£30-£720 a year. An outfit allowance of £30 payable on first appointment. Free passages, quarters and liberal leave on full salary. Candidates, aged about 40, must possess strong personality. Their previous experience must be that of Inspectors of Factories and Workshops, and must include the Inspection of Boilers, Plant and Machinery, including small Electric Light Plants, and particularly Cotton Ginning Plant. Candidates with good knowledge of Building Construction preferred. Must be prepared to leave England at an early date, and be able to drive and maintain a motor car.

M/1384. — ASSISTANT ENGINEERS (THREE) REQUIRED by the GOVERNMENT of NIGERIA for RAILWAY SURVEYS, for a tour of twelve to eighteen months, with possible extension. Free quarters and passages, and outfit allowance of £60 on first appointment. Liberal leave on full salary. Salary, £480 for three years, then £510, rising by annual increments of £30 to £720 a year, and thence rising by annual increments of £40 to £920 a year. Candidates, aged 25 to 35, must have passed Sections A and B of the Examinations to qualify for the A.M.I.C.E. Diploma, or hold professional qualifications recognised by the Institution of Civil Engineers as exempting from those examinations. Must have had experience on Railway Location.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 1813

Junior Draughtsmen (UNESTABLISHED) REQUIRED. Experience on War Stores, Commercial Vehicles, and Jigs, Tools and Gauges desirable.

Applicants must be British subjects over 21 years of age, and have served apprenticeship in engineering works.

Salary (42-hour week) 30s. 6d.-52s. plus variable bonus, according to age and ability (giving at present about 52s. to 82s.). Eligible for promotion.

Application forms, returnable by 17th May, 1929, may be obtained from CHIEF SUPERINTENDENT OF ORDNANCE FACTORIES, Royal Arsenal, Woolwich, S.E. 18. 1774

The Engineer

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PUBLIC NOTICES

Air Ministry.

DIRECTORATE OF TECHNICAL DEVELOPMENT.

DRAUGHTSMEN (CIVILIAN) REQUIRED. Candidates should have had good technical training, such as apprenticeship at a recognised engineering establishment and a knowledge of Elementary Mechanics and Mathematics. A knowledge of the elements of engineering design is also desirable, and experience in a drawing-office (preferably on Aircraft Work).

Starting salary up to 52s. a week, plus Civil Service bonus (which gives present total 82s. a week), according to qualifications and experience.

Ex-Service man preferred.

Applications, showing qualifications, &c., should be made to the OFFICER COMMANDING, Marine Aircraft Experimental Establishment, Royal Air Force, Felixstowe, Suffolk, quoting reference B338. 1795

Air Ministry.

DIRECTORATE OF TECHNICAL DEVELOPMENT.

TEST ASSISTANT REQUIRED for calculation and experimental work in connection with Aero-engine investigations.

Candidates should have had engineering works and drawing-office experience and technical training to the standard of the B.Sc. Degree.

Candidates must also be medically fit for flying and be willing to fly as observer.

Preference given, other things being equal, to an ex-Service man.

Starting salary about 60s. plus Civil Service bonus per week, which gives a present total weekly remuneration of £4 12s. 7d.

Write (quoting reference No. A.338), stating age, training and experience, to the CHIEF SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants. 1775

Royal School for Deaf and Dumb Children, Margate.

WORKING ENGINEER REQUIRED. Must have practical knowledge of Boilers, Steam-electric Generators, Motors, Battery, Well Pump, Water Softener, Calorifiers, Laundry, Swimming Bath, &c.

Apply, giving full details of training and experience, wages required (house provided), with copies of not more than three testimonials, to SECRETARY, 93, Cannon-street, London, E.C. 4. P5776

PUBLIC NOTICES

Armstrong College,

NEWCASTLE-UPON-TYNE.

(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.Sc. and the HONOURS DEGREE of B.Sc. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degre and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
1721 Newcastle-upon-Tyne.

MANCHESTER MUNICIPAL
COLLEGE OF TECHNOLOGY.
UNIVERSITY OF MANCHESTER.
(FACULTY OF TECHNOLOGY).
PRINCIPAL: B. MOUAT JONES, D.S.O., M.A.

EDMUND MILLS HARWOOD MEMORIAL SCHOLARSHIP.

The Governing Body announce the offer of a SCHOLARSHIP of the value of £50 per annum for three years, tenable in one of the University Engineering Courses in the College of Technology.

Forms of nomination and all information may be obtained on application to the REGISTRAR of the College.

Applications must be received on or before 15th June. 1754

PUBLIC NOTICES

Borough of Bexhill.

CORPORATION WATERWORKS.

The Corporation invite TENDERS for the LAYING and JOINTING of approx. 1540 YARDS of 4in. CAST IRON WATER MAIN in the parish of Herstmonceux, in the Hailsham Rural District.

Plans may be seen and specification and form of Tender obtained at the Water Engineer's Office, Town Hall, Bexhill-on-Sea, upon receipt of a deposit of One Guinea, which will be returned after the Council have dealt with the Tenders to contractors who have submitted bona fide Tenders.

Sealed Tenders, endorsed "4in. Water Main," on the prescribed form, together with priced schedule, must be delivered at the Town Clerk's Office, Town Hall, Bexhill-on-Sea, not later than Noon on the 15th May, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

S. J. TAYLOR,
Town Clerk.

Town Hall, Bexhill,
29th April, 1929. 1770

Borough of Bexhill.

CORPORATION WATERWORKS.

The Corporation invite TENDERS for the SUPPLY of approx. 1540 YARDS of 4in. C.I. PIPES and about a TON of C.I. SPECIALS.

Specification, schedule and form of Tender may be obtained at the Water Engineer's Office, Town Hall, Bexhill-on-Sea.

Sealed Tenders, endorsed "Tender for 4in. Water Pipes," must be delivered at the Town Clerk's Office, Town Hall, Bexhill-on-Sea, not later than Noon on the 15th May, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

S. J. TAYLOR,
Town Clerk.

Town Hall, Bexhill,
29th April, 1929. 1771

Canvey Island Urban District Council.

BRIDGE OVER BENFLEET CREEK.

The Council invite TENDERS for the CONSTRUCTION of APPROACH ROADS, upon earth embankments, and OPENING SPAN BRIDGE, in steel and concrete, over Benfleet Creek. Specification, schedule of quantities, form of Tender, &c., may be obtained and the drawings seen on and after Monday, May 6th, 1929, at the office of the Engineer, Mr. H. J. Deane, B.E., M. Inst. C.E., &c., at 53, Victoria-street, Westminster, London, between the hours of 10 a.m. and 5 p.m., on payment of a deposit of Five Guineas, which will be refunded on receipt of a bona fide Tender within the prescribed time. Extra copies of the schedule of quantities may be obtained at the price of Half-a-Guinea (non-returnable) each. Cheques and money orders to be made payable to the Canvey Island Urban District Council. Sealed Tenders, endorsed "Tender for Bridge Over Benfleet Creek," must be delivered to the undersigned before Noon on Monday, May 27th, 1929. The Council does not bind itself to accept the lowest or any Tender.

ARTHUR G. J. CORNNER,
Clerk to the Council.

Council Offices,
Canvey Island, Essex,
30th April, 1929. 1778

Wolverhampton Union.

NEW CROSS INSTITUTION, HEATH TOWN.
TO BOILERMAKERS.

The Guardians invite TENDERS for ONE WATER-TUBE STEAM BOILER for 12,000 lb. steam per hour, in accordance with specification and plan prepared by Messrs. Edwards and Shaw, 105, Colmore-row, Birmingham.

Conditions of contract, specification, and form of Tender may be obtained at my office, Stafford-street, Wolverhampton. Applications must be made not later than Wednesday, 8th May, 1929, and must be accompanied by the sum of Three Guineas, which will be returned on receipt of a bona fide Tender.

A. G. ALDRIDGE,
Clerk to the Guardians.

Poor Law Offices, Wolverhampton. 1786

City of Hull Water and Gas Department.

TECHNICAL ENGINEERING ASSISTANT.

The Water and Gas Committee are prepared to receive APPLICATIONS for the POST of TECHNICAL ENGINEERING ASSISTANT.

Applicants must not be over 40 years of age and must have a sound knowledge of Steam and Diesel Engines and Deep Well Pumps, also the preparation of Parliamentary Plans, &c.

The successful applicant must undergo a medical examination, and the appointment will be subject to the result of such examination being staisfactory. In the event of the post becoming a designated post under the provisions of the Local Government and Other Officers' Superannuation Act, 1922, the successful candidate will be required to contribute to the Hull Corporation's Scheme under the said Act.

The salary paid will be at the rate of £450 per annum; no bonus.

Applications to be sent in on the form provided, stating age, experience, qualifications, &c., together with copies of not more than three recent testimonials, will be received by me not later than Friday, the 24th May, 1929.

Canvassing members of the Committee will disqualify applicants.

W. D. BINGHAM,
Water and Gas Engineer.

Guildhall, Hull,
May, 1929. 1781

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PUBLIC NOTICES

Municipal Corporation of RANGOON.

APPOINTMENT OF SECOND OFFICER, FIRE BRIGADE.

The Municipal Corporation of Rangoon invites APPLICATIONS for the POST of SECOND OFFICER, FIRE BRIGADE. Applicants must be qualified and trained mechanical engineers with fire brigade experience, and should not be under 25 or over 30 years of age. They should also state nationality, qualifications and what previous experience they have had in the working of a Fire Brigade. Preference will be given to candidates who are members of the Institute of Fire Engineers (class to be stated). An intimate knowledge of Internal Combustion Engines and Pumping Machinery is essential. The salary offered is Rs. 400 for the first year, rising by annual increments of Rs. 20 to Rs. 500 per month, with free quarters, lights, fans, and water, and the use of a service car while on duty. The appointment will be permanent subject to a probationary period of one year. A free first-class passage from the nearest port to Rangoon will be provided and leave and leave allowances will be in accordance with the Fundamental Rules applicable to officers in superior service under the Government of India. The officer appointed will be required to subscribe to the Municipal Provident Fund. Subscriptions are payable at the rate of 8 1-3 per cent. of salary and an equal amount is contributed by the Municipal Corporation. The successful candidate will be required to pass a medical examination by a medical officer nominated by the Corporation or its duly authorised agents and to abide by all the rules and regulations in force for officers of the Corporation of Rangoon.

Applications should be forwarded to the undersigned and should reach them not later than the 15th May, 1929. All applications will be sent to Rangoon for final selection. Application forms are not supplied.

OGILVY GILLANDERS & COMPANY,
Ref. R.2988, Sun-court,
1729, 67, Cornhill, London, E.C.

Municipality of George Town,

PENANG, STRAITS SETTLEMENTS.
MUNICIPAL ENGINEER'S DEPARTMENT.
APPOINTMENT OF ASSISTANT MUNICIPAL ENGINEER.

The Municipal Commissioners of George Town, Penang, REQUIRE an ASSISTANT ENGINEER, age 22 to 23 years and unmarried, for the permanent staff of their Municipal Engineer's Department, the appointment being in the first instance on a three years' agreement.

Applicants must have had a good technical education and have served a regular training as pupil and assistant in a Municipal or County Engineer's Office, and must possess experience in Municipal and General Engineering Work, including roads, buildings, bridges, sewerage and conservancy work, and the control of workmen. Preference will be given to candidates who have passed the Testamur Examination of the Institution of Municipal and County Engineers.

Salary, 4800 dollars for the first year, 5100 dollars for the second year, and 5400 dollars for the third year of the agreement. In the event of the appointment being continued after the expiry of the agreement the salary will rise in accordance with the Commissioners' salary scheme. Salary will be paid monthly in dollars the currency of the Colony, the value of the dollar being 2s. 4d. sterling. In addition, there is at present a temporary allowance of 10 per cent. on the salary for unmarried men. The pay of the appointment at the above rate for the first year, including the temporary allowance, would be £616. An allowance of 110 dollars per month for the maintenance of a motor car when on duty will be granted. Free passage will be provided, with half-pay during the voyage out. The selected candidate must pass an approved medical examination.

Eight months' leave, on full pay, with passage paid, is usually granted after four years' service, if the appointment be continued for that period.

There is a compulsory Superannuation and Provident Fund for municipal servants, of which the person appointed must become a member. Its chief points are as follows:—Members contribute 10 per cent. of their salaries and the Commissioners make a donation of a similar sum. After ten years' approved service, or at death, or (with certain conditions) on forced retirement at any time, the amount standing to an officer's account (contributor's subscriptions and Commissioners' donations with accrued interest) is paid to him or his representatives, as the case may be.

Penang is one of the beauty spots of the eastern world, George Town is situated on the coast within 3 miles of the Penang Hills Railway, which runs up to the Hill Station, 2400ft. above sea level. There are excellent facilities for swimming, riding, golf, tennis, cricket and all usual games. The population of George Town is 134,000, and day temperature about 80 deg. to 90 deg. F.

Applications, stating whether married or single, and giving age and birthplace, with details of education, training and experience generally, and referring particularly to the qualifications mentioned above, and accompanied by copies (not originals) of testimonials, to be lodged with Messrs. PIERCE and WILLIAMS, MM. Inst. C.E., 64, Victoria-street, London, S.W. 1, Agents for the Commissioners, not later than Friday, 10th May, 1929.

Further particulars, if desired, can be obtained from the Agents. 1777

Parish of St. Pancras.

GUARDIANS OF THE POOR.
ENGINEER.

WANTED, for the Highgate Hospital, Dartmouth Park-hill, N. 19, an ENGINEER.

Salary £6 per week, increasing to £6 10s. per week at the end of 12 months' service.

Candidates must be between the ages of 34 and 40 years and hold a First Class Board of Trade Certificate. Preference will be given to those with marine experience.

The person appointed will be required to take charge of the engineering department of the Hospital, including calorifiers, laundry and kitchen apparatus.

Forms of application may be obtained at my office, as below, by sending a stamped addressed foolscap envelope, and should be returned to me not later than the 16th May, 1929.

Canvassing is not permitted by the Guardians and will disqualify any candidate.

B. CHAPMAN,
Clerk to the Guardians.
Guardians' Offices, Town Hall,
Pancras-road, London, N.W. 1,
29th April, 1929. 1776

Waterford Harbour.

The Commissioners for Improving the Port and Harbour of Waterford REQUIRE the SERVICES of a fully qualified experienced TEMPORARY ASSISTANT ENGINEER, to carry out under the direction of the Harbour Engineer a survey of portion of the River Suir about 2500ft. long by 700ft. wide and situate about 3 miles from Waterford City.

Only engineers who are fully qualified and are experienced in tidal survey and sounding work, are good draughtsmen, and conversant with taking out clay and rock quantities, need apply.

Applications, stating age, experience, qualifications, and accompanied by copies of testimonials, with salary required, to be addressed to the Secretary and General Manager, Waterford Harbour Commissioners, on or before the 11th May, 1929.

Canvassing of members of the Board will disqualify a candidate.

For any further particulars apply to the Harbour Engineer, Harbour Engineer's Office, Waterford.

AUSTIN A. FARRELL,
Secretary and General Manager.
Harbour Office, Waterford,
24th April, 1929. 1763

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

BOX 1508.—Advertisers THANK APPLICANTS for the POST of Engineer, Manager and Secretary, and inform them that the POST IS FILLED. 1784 A

SITUATIONS OPEN (continued)

WANTED, ASSISTANT or JUNIOR ENGINEER, with high technical qualifications in Civil Engineering; experience in Estate Work and Drainage Schemes desirable, but not essential.—Address, giving full details, 1768, The Engineer Office. 1768 A

WANTED for Canadian Company, Experienced DETAILERS and CHECKERS for Structural Steel and Bridge Building. Highest salaries to competent men.—Apply immediately by letter only to W. B. C., c.o. John Coates and Co., Ltd., Victoria House, Melbourne-place, Strand, London, W.C. 2. 1700 A

WANTED, PRODUCTION SUPERINTENDENT for large works in North of England dealing with batch production. Applicants must have had thorough works experience in this type of production and be accustomed to handling all matters connected with shop orders, progress, chasing, bulletin boards, &c. Excellent opening for keen man who can show good record. Mass production men need not apply.—Address, 1642, The Engineer Office. 1642 A

WANTED, Thoroughly Competent Young and energetic MAN who has been thoroughly trained in Boiler and Tank Building; must be well up in the latest practice of Hydraulic and Pneumatic Riveting and Electric Welding. Permanent situation and good salary for the right man.—Address, stating age, salary, and experience, 1687, The Engineer Office. 1687 A

A FIRM of Reinforced Concrete Engineers has a VACANCY for a REPRESENTATIVE, having knowledge of Reinforced Concrete Design. Applicants should have intimate connection with London Consulting Engineers for firms abroad. State full particulars of experience, age, and salary required.—Address, 1761 The Engineer Office. 1761 A

A VACANCY Exists in a British Firm of Marine Diesel Engine Manufacturers for a REPRESENTATIVE to obtain orders. Applicants must have a thorough practical and technical knowledge of the Construction and Running of both the Two and Four-stroke Types of Diesel Engines. State age, experience, and salary required, and forward copies of testimonials.—Address, 1812, The Engineer Office. 1812 A

ENGINEERING COMPANY (London) REQUIRE SERVICES of BUYER with experience of General Purchasing and knowledge of Engineering Markets.—Address, stating age and salary required, P5780, The Engineer Office. P5780 A

EXPERIENCED RATE-FIXER REQUIRED for General Engineering Works; thorough knowledge of setting process and times (premium bonus) for fitting and all classes of machine work. State age, experience and salary expected.—Address, 1783, The Engineer Office. 1783 A

INSPECTION SUPERINTENDENT REQUIRED for works employing about 2000 hands. Candidates must be used to latest methods of interchangeable manufacture and accustomed to controlling first-class product. Applicants should enclose photographs, which will be returned.—Address, 1643, The Engineer Office. 1643 A

MAINTENANCE MECHANIC REQUIRED, with sound experience in Running and Repairs to Turbines and Water-tube Boilers for modern industrial power station in Kent.—Apply, giving full particulars training, experience, age, and wages required, to Box 2343, c.o. A. W. Brown, 39, Tothill-street, S.W.1. 1801 A

OLD-ESTABLISHED ENGINEERING FIRM REQUIRES first-class COSTING ACCOUNTANT; qualified man with practical experience preferred. Progressive salary and prospects.—Address, with full particulars, 1787, The Engineer Office. 1787 A

REPRESENTATIVE to Call on Corporation Tram and Bus Engineers and Bus Fleet Owners. Must state connection and salary wanted.—Address, P5790, The Engineer Office. P5790 A

SITUATIONS OPEN (continued)

REQUIRED for an English Structural Works in India, a young works-trained STRUCTURAL ENGINEER as Assistant Manager. Age 25 to 27, unmarried. Salary Rs. 600 per month; must be well educated.—Apply with copies of testimonials and photograph, to Z.G. 182, Deacon's Advertising Agency, Fenchurch-avenue, London, E.C. 3. 1799 A

THE BRITISH STEELWORK ASSOCIATION, recently formed with the object of increasing the uses of structural steel by means of research, publicity, and propaganda, REQUIRES a fully qualified ENGINEER as DIRECTOR. He must possess literary ability and have good presence and address. Age 35/45. Knowledge of French and German an advantage.—Applications should be made by letter, giving particulars and salary required, to Messrs. PEAT and CO., 11, Ironmonger lane, E.C. 2. 1707 A

TIME STUDY and RATE SETTER, Experienced; no others need apply. Should have fair knowledge of Mechanical Processes, and should be able to offer suggestions for better methods, tools and equipment and to judge when work is being done most efficiently. Covering all branches of work in a Steel Furniture and Office Equipment Factory. State fully past experience, age and wages expected. References will be required. Replies confidential.—Address, 1757, The Engineer Office. 1757 A

WORKS ENGINEER REQUIRED by Large Manufacturing concern; age must not exceed 32. Applications to be accompanied by copies of recent testimonials.—Address, 1785, The Engineer Office. 1785 A

WORKSHOP MANAGER WANTED for Works in Ceylon, employing about 200 hands; must be expert in Machine Tools, capable of renovating and modernising present plant and increasing production; good knowledge of small tools essential. Age 26-30; single; four years' agreement. Salary about £500 per annum, with free passage.

Address, with copies only of testimonials, P5782, The Engineer Office. P5782 A

WANTED, a DRAUGHTSMAN, Experienced in Hydraulic Machinery.—Apply by letter only, stating age, experience and rate of pay required, to THE HYDRAULIC ENGINEERING CO., Ltd., Chester. 1765 A

WANTED AT ONCE, GENERAL ENGINEERING DRAUGHTSMAN, with knowledge of Plant Lay-out and good Structural Experience.—Apply, stating age, salary required and experience, to FRASER and CHALMERS ENGINEERING WORKS, Erith, Kent. 1808 A

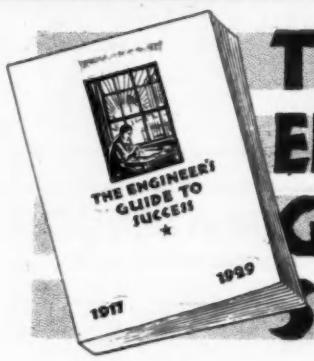
WANTED, CHIEF DRAUGHTSMAN, with Intimate knowledge of design of High-speed Petrol Engines; a knowledge of Diesel Engine design also a recommendation.—Address, stating full experience and wages required, 1673, The Engineer Office. 1673 A

WANTED, DRAUGHTSMAN, Used to the Design of Medium-weight Machine Tools. State age, wages, and experience.—Address, WEBSTER and BENNETT, Ltd., Coventry. 1644 A

WANTED, DRAUGHTSMAN, with General Engineering experience.—Address, stating experience, age and salary required, 1809, The Engineer Office. 1809 A

WANTED, Experienced DRAUGHTSMAN for an Iron and Steel Works Office.—Address, with full particulars, 1779, The Engineer Office. 1779 A

WANTED IMMEDIATELY, Thoroughly Competent CHIEF DRAUGHTSMAN for all classes of Railway Wagon Work, home and foreign.—Apply by letter in the first place, stating age, experience, and salary required, to MANAGING DIRECTOR, Charles Roberts and Co., Ltd., Horbury Junction, near Wakefield. 1683 A



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SITUATIONS OPEN (continued)

WANTED, ONE or TWO DRAUGHTSMEN, with good knowledge of Mechanism generally, and preferably some experience in high-class Steam Engine Design. Midland country district. State age, salary, experience, and when at liberty.—Address, 1810, The Engineer Office. 1810 A

WANTED, TEMPORARY MECHANICAL DRAUGHTSMAN, with general experience and shop training. State age, details of experience and salary.—Address, P5799, The Engineer Office. P5799 A

A FIRM of BANKERS' ENGINEERS, with Works in North London district, REQUIRE a JUNIOR DRAUGHTSMAN; well educated, knowledge of Constructional Engineering an advantage; permanency for suitable man.—Address stating full experience and salary required, P5791 The Engineer Office. P5791 A

CIVIL ENGINEERING DRAUGHTSMAN REQUIRED in Consulting Engineers' Office in Westminster, experienced in Detailing Foundations, Reinforced Concrete Work, and Steel Structural Work. Salary according to experience.—Address full particulars to P5789, The Engineer Office. P5789 A

DRAUGHTSMAN, Mechanical-Electrical. Experienced in Design of Large A.C. Machines. Full particulars of experience, age, and salary required.—Address, 1759, The Engineer Office. 1759 A

DRAUGHTSMEN REQUIRED. Applicants must be experienced in General Engineering Work, Chemical Plant Design and Lay-out, Steel Structural Work, Driving Arrangements, &c.—Reply, stating age, experience and salary required to IMPERIAL CHEMICAL INDUSTRIES, Ltd., British Dyestuffs Corporation, Ltd., P.O. Box A 38, Huddersfield, and mark envelope "Draughtsman." 1760 A

DRAUGHTSMAN REQUIRED, with Experience up-to-date Steam Turbine Practice.—Write, stating age, salary required, and experience, to Box 641, Sells Advertising Offices, Fleet-street, E.C.4. 1807 A

DRAUGHTSMEN, TWO First-class Men, WANTED IMMEDIATELY, experienced in detailing Flax Machinery. Provinces. Temporary, but may lead to permanency.—Address, stating age and salary required, 1804, The Engineer Office. 1804 A

DRAUGHTSMAN WANTED for Plant and Machinery development. Only men with experience need apply. Give full experience, wages read.—S. SMITH and SONS, Cricklewood Works, N.W. 2. 1670 A

DRAUGHTSMAN, with Experience of Power Transformers.—Apply, stating age, experience, and salary required, to MANAGER, Drawing-offices, B.T.H. Co., Ltd., Rugby. 1684 A

FIRST-CLASS MECHANICAL DRAUGHTSMAN WANTED, with sound knowledge of Overhead Electric Travelling Crane Practice. Good opening for man with ability and initiative. State experience, age, salary required, technical qualifications.—Address, 1805, The Engineer Office. 1805 A

JIG and TOOL DRAUGHTSMAN REQUIRED. First-class man, accustomed to Light Engineering Work.—Apply, stating age, experience and salary required, to DRAUGHTSMAN, Tangyes Limited, Cornwall Works, Smethwick, Birmingham. 1769 A

JUNIOR DRAUGHTSMAN REQUIRED for Engineering Works specialising on Worm Reduction Gears and Advertising Devices. Opportunity given for practical experience.—Letters, giving experience, salary required, &c., MORTIMER ENGINEERING Co., Acton-lane, Harlesden. P5748 A

JUNIOR MECHANICAL ENGINEER REQUIRED by large gas undertaking, age 21 to 24, well educated and fully trained; preference given to public school boy with railway shop training. Prospects good, pension fund and co-partnership scheme on completion of one year's satisfactory service. State salary required.—Address, 1584, The Engineer Office. 1584 A

MECHANICAL DRAUGHTSMAN WANTED. Experienced on Ships' Deck Machinery, Windlass, Capstans, Steering Gears; must be able to design, estimate and carry through the details.—Address, stating experience, age and salary expected, and when able to commence, 1758, The Engineer Office. 1758 A

SENIOR DRAUGHTSMAN REQUIRED, with Wide experience in design and layout of Industrial Plant, accustomed to accurate estimating. Regular staff position if suitable.—State age, full particulars of experience, and salary required, to "G. D. O. APPOINTMENT," Lever Brothers, Limited, Port Sunlight, Cheshire, marking envelope "Private." 1678 A

SEVERAL DRAUGHTSMEN REQUIRED for the Design of Oil Circuit Breakers. Previous experience in this class of work desirable, but not essential. Also SEVERAL DRAUGHTSMEN REQUIRED for Lay-out of High-tension and Low-tension Switchboards.—Apply, stating age, experience and salary required, to THE GENERAL ELECTRIC CO., Ltd., Witton, Birmingham. 1793 A

STRUCTURAL ENGINEERING DRAUGHTSMEN REQUIRED in London Office for the Design of Steel-framed Buildings and other Structural Steelwork.—Write, stating age, particulars of training, and experience and salary required, to "P.N.," c.o. Charles Barker and Sons, Ltd., 31, Budge-row, E.C. 4. 1794 A

TOOL DESIGNER WANTED, Capable of Designing Tools and Jigs for Presswork and Machining Operating. Must have had experience in improving Manufacturing Methods and able to initiate new processes. Replies should state in detail experience and give age.—Address, 1702, The Engineer Office. 1702 A

SITUATIONS WANTED

ADVERTISING. — ASSISTANT ADVERTISING MANAGER to large firm is OPEN to a suitable OFFER.—Address, P5794, The Engineer Office. P5794 B

BUYING DEPT. ASSISTANT SEEKS CHANGE; fully experienced, capable take charge, 20 years' all-round knowledge of supply sources.—Address, P5788, The Engineer Office. P5788 B

COMMERCIAL VEHICLE TRADE. — A gentleman, with exceptional technical and business ability, embracing Design and Construction, and considerable experience in Works Organisation and Reorganisation, will be FREE in a few months to ACCEPT POSITION with any firm requiring a man for a highly responsible and managerial position.

Full particulars on request.—Address, 1677, The Engineer Office. 1677 B

ENGINEER (25), Varied Experience, Mechanical, building, public works, some electrical, estimating, costs, good draughtsman, commercial experience, DESIRES CHANGE; would suit as General Assist. to Water Eng.—Address, P5787, The Engineer Office. P5787 B

ENGINEER'S SECRETARY (Lady) SEEKS ENGAGEMENT. Eight years' experience form of correspondence and report dealing with machinery and statistical detail appertaining to manufacture.—Address, P5796, The Engineer Office. P5796 B

ENGINEER SEEKS POSITION as Works Manager or Production Superintendent, General Engineering or Batch Production; 17 years' executive position; first-class references; graduated through works, D.O. and foundry; excellent record, organisation and control.—Address, P5801, The Engineer Office. P5801 B

For continuation of Small Advertisements see page 4.

A Seven-Day Journal

A Non-stop Flight to India.

ON Wednesday of last week, April 24th, Squadron-Leader Jones-Williams and Flight-Lieutenant Jenkins left Cranwell Aerodrome at 10.45 a.m. on a specially built Fairey-Napier monoplane to attempt a non-stop flight to Bangalore, for the purpose of establishing a world's long-distance record. The machine, it is understood, took off with about 3½ tons of petrol on board, and got away in a comfortable manner, after a run of about 1200 yards. At 1.45 p.m. on the following day it passed over Baghdad, and at 11.30 a.m. last Friday it passed over Karachi. It had still another thousand miles to travel before reaching Bangalore, but the petrol supply was exhausted, and after flying 90 miles beyond Karachi, the machine was turned back and landed at that city. Under normal conditions the fuel carried should have been easily sufficient to take the machine to Bangalore, but throughout the flight bad weather was encountered. Rain, snow, and dense clouds attended the flight across Europe, and during the passage down the Persian Gulf the weather was so bad that the average speed of the machine was reduced to about 65 miles an hour. The total distance flown from Cranwell to Karachi was about 4130 miles, and was accomplished in 50 hours 48 min. The world's long-distance non-stop record of 4466 miles, therefore, remains with the Italians, Captain Ferrarin and Major del Prete, who flew from Rome to Brazil. Doubtless, the Fairey-Napier monoplane, the capabilities of which have been so well proved under the trying circumstances of last week's flight, will soon be again employed on another effort to secure the record for this country.

The Southern Railway and Road Transport.

IT is officially stated by the Southern Railway Company that it has reached an agreement with the National Omnibus and Transport Company, Ltd., covering the operation of omnibus services in Devon, Cornwall, Dorset, Somerset, and Wiltshire. A new company, to be known as the Southern National Omnibus Company, Ltd., is to be formed with a capital of £150,000 in preference shares and £350,000 in ordinary shares. This company will take over from the National Omnibus Company certain services in the counties stated, and will operate them in the joint interests of the omnibus and railway companies. The agreement is dated to operate from January 1st, 1929. There will be an equal number of representatives from the Southern Railway and the National Omnibus Company on the board of the new company, which will be presided over by Sir John Jarvis. About sixty-four passenger services fall within the scope of the agreement.

New British Airports.

THE invitation extended some time ago by the Air Ministry to the principal towns of Great Britain to consider the establishment of local airports within their territories appears to have met with a very satisfactory response. Thirty-one towns now have sites which have been approved by the Ministry as suitable for civil aerodromes, twenty-four other towns are awaiting visits from the inspecting staff of the Directorate of Civil Aviation, and a further nineteen towns have gone so far as to apply for the general notes on aerodrome selection which the Ministry has prepared. Of the thirty-one towns with approved sites, four—namely, Manchester, Blackpool, Bristol, and Nottingham—have actually purchased the land, and when these sites have been properly developed, they will provide aerodromes suitable for every class of aircraft. Manchester has a temporary aerodrome already in use while the permanent aerodrome at Chat Moss is being made ready. The aerodrome at Bristol is situated at Whitchurch, three miles to the south-east of the town. It may develop into an important station on the London–Dublin air route, for it possesses certain advantages—including a shorter sea passage—over the route *viâ* Liverpool. The establishment of a London–Dublin air service is now receiving the favourable consideration of the Irish Free State Government. At Hull, Leith, and Liverpool water areas have been chosen, and Orders in Council, it is understood, are now being prepared, which will constitute these areas ports for aircraft arriving from overseas.

The New Harwich-Esbjerg Motor Ship.

ON Saturday last, April 27th, the new passenger and cargo motor vessel "Esbjerg," recently completed for the United Steamship Company of Copenhagen and London, by the Elsinore Shipbuilding Company, Ltd., and Burmeister and Wain, Ltd., left Harwich for Esbjerg, on her return maiden voyage. In her general arrangement she follows closely the design adopted for the "Parkeston," which was fully described in THE ENGINEER for August 14th and 21st, 1925, and for her sister vessel the "Jylland." In the new ship, however, single-acting, four-stroke, trunk piston engines, operating on the airless-injection system, with superchargers, are installed. The first set of engines of this type was fitted in the "C. F. Tietgen," a motor vessel constructed for the same owners, and the new machinery is also generally similar to that of the ships of the Ulster Imperial Line, which is described elsewhere in to-day's issue. The engines on the "Esbjerg" consist of two six-cylinder units, with a cylinder bore of 550 mm. and a stroke of 900 mm., which are each designed for an output of about 1950 I.H.P. at 195 r.p.m. With, however, the superchargers in operation, the total output can be increased from 3900 to 4300 I.H.P., and the speed of the ship raised to over 16 knots. The maiden voyage from Denmark to England was, we understand, a very successful one. It is of interest to recall in this connection that on Monday last, April 29th, the Danish Minister officially opened the new East Smithfield depôt of the London and North-Eastern Railway, which has a direct railway connection with Parkeston Quay, and has been specially laid out for the reception, storage and delivery of the large quantities of Danish bacon which are brought over each week from Esbjerg to Harwich in the insulated cargo spaces of the motor ships we have referred to.

Exhaust Steam Turbine Systems.

AT a meeting of the Society of Consulting Marine Engineers and Ship Surveyors, held in London on Friday evening last, April 26th, Mr. R. J. Butler, of William Beardmore and Co., Ltd., Dalmuir, gave a paper on the Bauer-Wach exhaust turbine system and its application to steamships. He recalled the history of the exhaust steam turbine and its installation by Denny Brothers on the steamer "Otaki." With exhaust steam turbines driving the propellers direct, the economies, he held, were of necessity small, because the revolutions were too high for propeller efficiency and too low for economical turbine design. The introduction of gearing by Sir Charles Parsons had made possible the coupling of the exhaust turbine to the main shaft. In the Bauer-Wach system, the problem of the superimposition of the substantially uniform torque of the turbine on the highly fluctuating torque of the reciprocating engine had been successfully overcome by the introduction of a flexible coupling of the hydraulic type. Since the first equipment was installed in 1926 the system had been successfully applied to reciprocating-engined steamships aggregating over half a million I.H.P., of which about one-half had been converted to the system, the other half being new. Over 120 installations of the Bauer-Wach type were now being installed in vessels with propelling powers ranging from 1700 I.H.P. on a single shaft to 12,000 I.H.P. on twin screws. In a steamer recently converted for the Hamburg-South America service it had been possible by reducing the temperature range and velocity in the low-pressure cylinder exhaust ports and increasing the receiver and release pressures to raise the steam efficiency of the cylinder from 45½ to 70½ per cent., besides obtaining work from the turbine. In considering the application of the system, it was necessary for owners to satisfy themselves that the ships were suitably designed for higher speeds, and that the extra power obtained could be used to give extra speed without greatly increasing the resistance of the ship.

Proposed Large Liners for Italy.

FROM a report from Rome it is understood that the three largest Italian shipping concerns, the Cosulich Line, the Lloyd Sabaudo Line, and the Navigazione Generale Italiana Line, are each to add to their existing fleets a new 46,000-ton liner, with a speed of 27 knots, which will be employed in the North American trade. In addition, it is stated that the Societa Meridionale Navigazione will shortly order two liners of 32,000 tons and having a speed of 22 knots, for the South American service. It is expected that the cost of the ships will be not less than ten to eleven million pounds, 60 per cent. of which is to be borne by the shipping companies and 40 per cent. by the Institute for Naval Credit, which is a Government-controlled undertaking. There are now seven large motor liners and steamships in the Italian mercantile fleet and a large number of vessels of smaller tonnage have been added in recent years. There is no doubt that the decision to enter the North Atlantic trade with still larger ships has been occasioned by recent construction, and the new shipbuilding programmes of Great Britain, America, France and Germany.

Safety of Life at Sea.

THE International Conference on the Safety of Life at Sea has now been in session for a little over two weeks, and good progress is being made, we are given to understand, with the various subjects under consideration. The first four committees which were formed dealt with ship construction, navigation, wireless telegraphy, and boats and life-saving appliances. It has now been found necessary to appoint sub-committees which will deal with the different branches of each section. In the first section sub-committees dealing with subdivision, structure and openings, stability and different categories of ships and their voyages are now at work. Two sub-committees in the navigation section are dealing with ocean routes and meteorology in relation to safety of life at sea. The section on wireless matters is divided into three sub-committees, which are considering various technical matters, the type of ships which should be compelled to carry wireless equipment, and matters related to watch-keeping on different categories of ships. The section on lifeboats and life-saving appliances has appointed a sub-committee to deal with questions relating to the lifeboat equipment and the number of boats it is necessary to carry. Many of the members of the conference must be following with keen interest the evidence called by the Board of Trade in the inquiry into the loss of the "Vestris," which is still being continued at the home of the Institution of Civil Engineers. The question of the disposition of coal and cargo in the ship and the manner of loading has now been fully inquired into, and evidence with regard to the handling of the ship is being taken from previous officers and officers connected with the working of the ship. The first stage of the inquiry dealing with the loading and stowage of the ship has occupied seven days, and the court will now proceed to investigate the happenings on the last voyage.

Wages in the Shipbuilding Trades.

A CONFERENCE between the Shipbuilding Employers' Federation and the shipyard trade unions to discuss the application of the unions for an advance of 5s. per week has been fixed for Thursday, May 9th, and will take place in London. There is little indication so far of any change in the position in Belfast with regard to the withdrawal of the joiners from the shipyards of Harland and Wolff, Ltd., and Workman, Clark and Co. (1928), Ltd. The two yards referred to are unfederated and the local members of the Amalgamated Society of Woodworkers received permission from their executive to open negotiations with the Belfast employers for the increase of 3s., which a year ago the Shipbuilding Employers' Federation conceded to plain time workers. It may be recalled that the joiners were excluded from this increase, the reason given being that they had not suffered as many reductions as other trades and that they still retained 3s. of the old bonus. The shipyard joiners, on the other hand, maintain that the 3s. was given in the nature of a tool allowance. To enforce this claim, which has been refused by the Shipbuilding Employers' Federation on the ground that it would give preferential treatment to a particular section of workers, the Belfast joiners, after failing in their negotiations with the employers, withdrew their labour. The strike began on Monday, April 22nd, at a time when Harland and Wolff were very busy completing the two Belfast-Liverpool cross-Channel boats. Work has been suspended, and it is feared that if the dispute is a lengthy one other trades will be affected and work will be brought to a standstill. The Belfast trouble will not affect the conference to be held in London on May 9th to consider the application for a further increase of 5s., since neither the Amalgamated Society of Woodworkers nor the Boilermakers' Society are, we understand, among the unions which are applying for the new advance.

London's Bridges.

SPEAKING at a luncheon given on Monday by the Improvements and Finance Committee of the Corporation of London, Sir Percy Simmons, Chairman of the Improvements Committee of the London County Council, suggested that the Corporation should unite with the County Council and the Ministry of Transport in a round-table conference to discover what could be done in the best interests of London as a whole in the matter of improved cross-river traffic facilities. The Corporation has still to decide what steps to take regarding the proposed St. Paul's Bridge. The County Council has by no means solved its difficulties regarding the Charing Cross Bridge. Sir Percy's suggestion was that the Corporation should contribute something towards the cost of the Charing Cross road bridge, even although it was outside its area. The cost of the bridge and its approaches is estimated at £13,000,000, towards which the Ministry of Transport will contribute 75 per cent. The remaining 3¼ millions as at present planned are to be supplied by the County Council. Sir Percy desired to see the Corporation taking some share in meeting this heavy charge on the Council, in order that the Council might have a larger sum available to meet the cost of forming the approaches and new streets required in connection with the proposed Charing Cross Bridge. The Lord Mayor received Sir Percy's suggestion in a kindly spirit, but would not anticipate the Corporation's answer to it. Sir Percy incidentally stated that the Ministry of Transport and the County Council had agreed that Sir Edwin Lutyens should be asked to advise on the layout of the proposed bridge and its associated works.

The Shannon Power Scheme.

No. II.*

IN our previous series of articles we gave a brief account of the weir and intake building, views of which are given in Figs. 14 and 15. In July, 1927, the cofferdam for the No. 1 section of the weir was completed, and when pumped out the walls of the dam proved to be quite water-tight. Even during the long high-water period in the winter of 1927–1928, which necessitated the raising of the dam with sand bags, the dam fulfilled its purpose; only in a very few places did water percolate through. The dam presented the appearance of an island in the midst of extensively flooded country, and in its shelter men and machines worked to a depth of 36ft. below the level of the Shannon. As soon as the river bed inside the cofferdam had been made dry, excavation work for the first two weir openings and for the middle piers between the weir and intake building was begun. Some of the earth and rock material was loaded directly on to trains by means of a shovel excavator. A large part of these materials had, however, to be loaded by hand into trucks and large platforms, which were then removed from the foundation pit by the cable crane. The materials on the platforms were emptied into railway trucks by means of a special plant. Two cableway cranes extended over the weir building site, the River Shannon, and the greater part of the intake building situated on the right bank, each crane being constructed to carry 5 tons. On the right bank of the river the cranes had a common fixed tower, whilst on the left bank the towers were movable, so that the cranes could work over the whole area of the weir building site. The quality of rock and model tests indicated that excavation would have to be carried down below the bed of the river to a depth of 3·5 m., and this excavation was through a top layer of earth and boulders and then through fissured sandstone rock into sound hard red sandstone rock on which the superstructure was founded. The rock drilling was done with compressed air hammers operated by means of electrically driven Flottmann compressors with an output of 6 cubic metres per minute. Owing to percolation of water under the cofferdam through the upper fissured layers of rock the excavation became more difficult as it increased. During periods of high water in the Shannon the percolation was such that it required five pumps, with a combined output of 2000 cubic metres of water per hour, to keep the space within the cofferdam sufficiently dry to allow excavation to proceed. Excavation was carried on continuously, day and night, except for a blasting interval every five hours.

Before concreting could be started, important work had to be carried out in connection with the waterproofing of the rock foundation, a work of vital importance from the point of view of the stability of the structure. Under the spill basin on the tail-water side of the weir sill earthenware pipes were laid along the natural rock fissures. These were cased in lean concrete and were provided in places with vertical outlet pipes extending through the concrete to the surface of the spillway basin. In this way the stresses in the concrete of the spill basin caused by upward water pressure were avoided. To prevent the water percolating downstream through the fissures and cracks in the rock under the concrete weir sills, when the water level in the river rose, the rock was made water-tight by cement grouting. Two rows of holes 5 m. deep were bored by means of boring machines under the weir sill, thus cutting through the fissures in the rock. After the weir sill had been concreted the bore-holes and consequently the cracks and fissures were filled with cement grout under a pressure of 6 atmospheres. In this way, along the upstream side of the weir a watertight barrier reaching down to 8·5 m. below the former river bed was formed. Only after this preparatory work, which included cleaning the rock bed with steel brushes and with water under pressure, had been carried out could the concrete work for the weir be commenced. The abutments, spill basin and the first weir pier then quickly made their appearance. The actual concreting itself at the weir was carried out as follows:—

The aggregates from the silos, namely, sand, chips and broken stone, were dropped into tipping wagons in a tunnel under the silos. By means of an automatic weighing machine the wagons were provided with the necessary quantity of cement before being raised up a ramp to the concrete mixer. The concrete mixing plant for the weir and intake building is in one building and consists of two 1000-litre mixing machines. The finished concrete was first put on a conveyor belt on an arm that could move round a semi-circle. By means of this belt part of the intake building could be concreted directly. For the concreting of the remainder of the intake building and of the weir the belt first conveyed the concrete to the cable crane carriers of 2 cubic metres capacity, which in their turn brought it to the required place.

The bottom of the spill basin is provided with a granite facing or wearing surface 40–60 cm. thick to resist the great force of the water flowing over the weir. As soon as a layer of the foundation concrete of the spill basin was ready, the placing of the granite blocks was begun. The granite from the Aughrim (Co. Wicklow) quarries was carefully dressed into suitable blocks; it was then loaded by derricks and movable cranes on to flat trucks and transported to the cable crane, whence it was brought to the required place. Special gangs were employed for the correct placing of the blocks. The joints between the separate blocks were completely filled in with cement mortar, and the stones in the lower sill or stop wall of the spill basin, which are especially subjected to water action, were anchored in the foundation concrete by means of round steel bars.

As a final work before the opening of the cofferdam, and also as preparatory work for the other buildings, a new cofferdam section for the cofferdam system of the next weir section was constructed on the completed part of the weir.

In connection with the design of the weir, model experiments were carried out in the hydraulic laboratory of the Technical University, Berlin, under the supervision of Professor Ludin. The experiments were made under the instructions of the Minister of Industry and Commerce for the Irish Free State on the recommendation of Professor Meyer-Peter and Professor Rohn, advisory engineers to the Shannon power works. The object of the experiments was to determine what alterations to the proposed design of the weir—shown on the left of Fig. 16—were necessary to improve the discharge and reduce as far as economically practicable the erosive effect on the river bed downstream of the weir, the foundations being an outcrop of hard red sandstone covered with shingle. When the scheme is in operation, lake conditions will be extended practically up to the weir, and it may therefore be assumed that very little silt will be carried to the weir. Assuming no discharge through the head-race canal, the maximum flood to be discharged through the weir may be taken as 920 cubic metres per second, and to provide for this the following weir openings were taken:—Four openings, each 18 m. wide, with crests of the weir at level + 33·00, for the full development scheme, and two deep sluices, each 10 m. wide, with the crest of the weir at level + 24·80. The upstream water level is fixed at + 35·70, and the downstream level is estimated at + 28·20. The average level of the river bed at the weir is + 24·50, the upper surface of rock being taken at + 22·00. The model of the weir was made to a scale of 1 : 50, and the relation between the results of the experiments and those likely to occur in the actual structure was obtained by means of "model rules."

In the preliminary experiments, the two deep sluices were situated at the right bank of the river, but owing to the heavy erosion downstream of those adjacent to the head-race bank and intake works, it was decided to alter their position to the centre of the river, thus giving a more symmetrical flow and confining possible erosion to the centre of the river.

FIG. 14—INTAKE BUILDING, WEIR AND FISH PASS

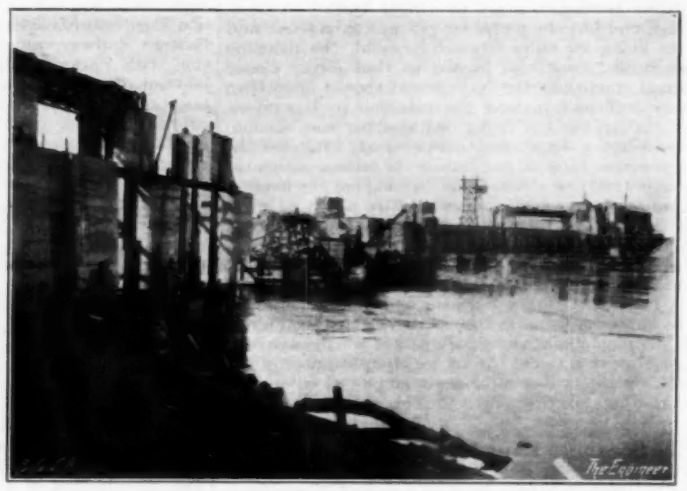


FIG. 15—WEIR INTAKE BUILDING—UPSTREAM SIDE

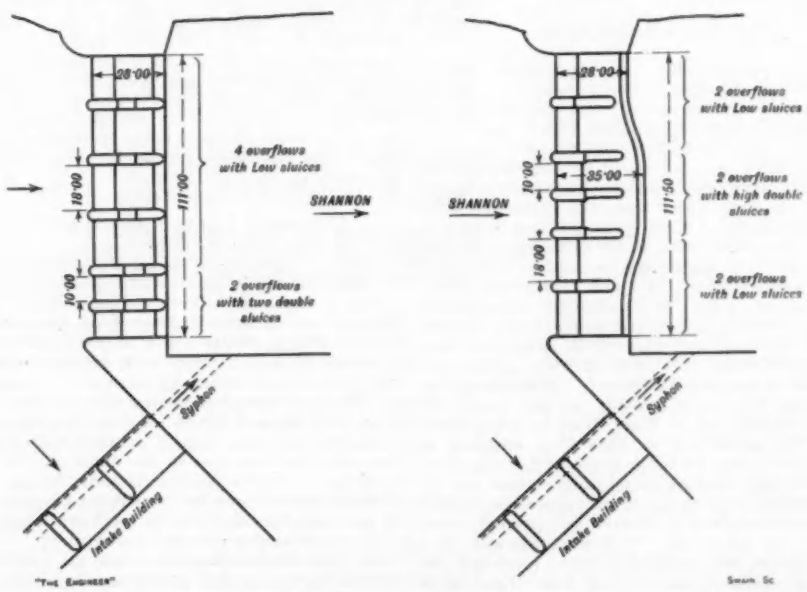


FIG. 16—PLANS OF WEIR

* No. I. appeared April 26th.

These experiments also showed that improvements could be made on the section of the weir to increase the discharge. In the succeeding experiments the cross sections of the weir were altered to the form indicated by the preliminary experiments, giving an increased discharge, and the deep sluices were removed

FIG. 17—MODEL "A"

to the centre. The two outside sluices could, however, only be made three-fifths their correct width, owing to laboratory conditions. Great care was paid to the selection of material representing the river bed, and for the model Professor Ludin selected sieved sand from 2·5 mm. to 5 mm. in size as most suitable for representing the sandstone rock of the bed of the river.

The discharge on the model was determined by a calibrated clear overfall weir. For adjustment of water levels hook gauges were fixed 1 m. above and 6 m. below the model weir. The discharges measured on the model, when increased according to "model rules," gave a practical agreement with theoretical calculations for discharge on the actual weir. Five experiments were carried out on the modified model "A." (1) One weir sluice—No. 2—opened and the remainder closed, discharge 141 cubic metres per second upstream water level + 35·70, downstream water level + 25·71. The erosion on the downstream bed of the river was carried down to + 19·00, after which erosion was practically unchanged.

(2) Three 18 m. sluices—Nos. 1, 2, and 3—open, the remainder closed. Discharge, 414 cubic metres per second; H.W.L., 35·70; L.W.L., 26·88. Very little erosion occurred.

(3) All 18 m. sluices open and two deep sluices partly and equally open. Discharge, 920 cubic metres per second; H.W.L., 35·57; L.W.L., 28·08. The erosion on the downstream of weir was carried down to + 22·00.

(4) All 18 m. sluices open and one deep sluice partly open, the other closed. Discharge, 920 cubic metres per second; H.W.L., 35·57; L.W.L., 28·08. The erosion was carried down to + 19·00.

(5) Continuous test, changing five times from low to high water. The duration of the test was 10 hours, after which further change in the eroded area was practically negligible.

Tests 1 to 4 inclusive were each of one hour duration, after which further erosion was negligible.

The experiments, numbers 1 and 4, gave the worst erosion, and although they were made under very exceptional circumstances, it was decided to carry out further experiments with a view to diminishing the erosion. Fig. 17 shows that in experiment 1 on model A, a general view of which is shown in Fig. 18, there was no overlapping rolling water, this being partly due to the shape of the cross wall on the downstream side of the spill basin. Further experiments were made under condition 1, in which the model was altered. The pier extensions were omitted to allow lateral flow of water, and a vertical stop wall crest sloping slightly downstream giving improved conditions was adopted.

Experiment 4 was then repeated, and an attempt was made to confine the large wave within the spill basin, first by omitting pier extensions and altering the shape of the stop wall and by further lengthening the pier extensions, but the erosion was still serious.

As the result of further experiments in which the extension of the piers was increased, the height of these extensions varied, the length of spill basin was increased, and Professor Rehbock's toothed stop-wall tested, model "B"—see Fig. 20—was used. This model did not, however, embody Professor Rehbock's toothed stop wall. An almost equally satisfactory result was obtained with a continuous wall having a vertical face and horizontal sill slightly inclined in a downstream direction.

Five experiments were then carried out on model "B," these experiments being performed with the same conditions as for model "A." Under all conditions the depth of erosion was less than in model "A," the greatest erosion—down to level 19·90—taking place in experiment 5. A new set of experiments was then carried out under conditions likely to occur under the partial development scheme. The weir crests of the 18 m. openings were reduced to + 30·85 and the H.W.L. fixed at + 33·55. The erosion was in all cases less than under full development conditions. Overload conditions on models "A" and "B" were compared, the experiments showing in all cases least erosion for model "B." From observations of the various experiments, it was thought that by reducing the discharge through the deep sluices and correspondingly increasing the discharge through the 18·0 m. sluices for a maximum flow of 920 cubic metres per second, the erosion would be decreased. Under full development conditions, the crests of the 18·0 m. openings were arranged as follows:—Weir openings Nos. 1 and 4, + 33·00; weir openings Nos. 2 and 3, + 32·20. Experiments under these conditions were then made. Further alterations constituting a model "C" were tried on the pier extensions at the deep sluices, and on a section of the stop wall. The experiments showed that the pier extensions were objectionable, and that the stop wall adopted for model "B" was satisfactory. The guide partitions or pier extensions were then abandoned and experiments carried out under practically the same conditions as 5 "A" and 5 "B." The experiment was repeated five times. The total duration of flow was ten hours, which gave a maximum depth of erosion down to + 21·25. The discharge for this experiment "C" was:

132 + 197 + 131 + 131 + 197 + 132

= 920 cubic metres per second for all sluices open, and

132 + 197 + 262 + 0 + 197 + 132

= 920 cubic metres per second for one deep sluice closed.

The crests of the 18 m. weir openings 2 and 3 were then increased to level + 32·40, and the discharge arranged as follows:—

132 + 180 + 148 + 148 + 180 + 132

= 920 cubic metres per second, all sluices open.

132 + 180 + 296 + 0 + 180 + 132

= 920 cubic metres per second, one deep sluice closed.

The result of this experiment gave erosion to level + 21·00. The effect of using finer sand for the bed of the river was then tried, model "D"—see Fig. 19—being adopted. An experiment 5 E, similar to 5 B, was made, and gave erosion down to a maximum depth of 18·35 m. From the form of this erosion on the model, no danger to the safety of the structure is to be anticipated. Further experiments in which minor alterations to the stop wall were tried were

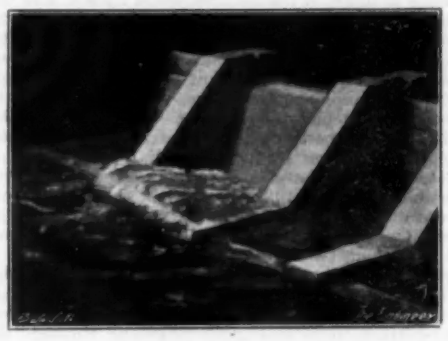


FIG. 20—MODEL "B"

carried out, but practically no alterations in the eroded river bed were found.

Auxiliary experiments were made. They resulted in (*a*) the rounding off of downstream faces of weir piers; (*b*) omission of extension of weir piers; (*c*) reduction of width of inlet sills of the deep sluices from 9·54 m. to 5·25 m.; and (*d*) adoption of a stop wall, 2·0 m. high above floor of spill basin.

As a result of these experiments, model "C" with slight modifications was adopted, thus giving a design shown on the right of Fig. 16 and in the right-hand drawings of Fig. 21.

Since these experiments, however, the two 18 m. wide openings with high sills and shallow gates on the left Shannon bank have been replaced by two 10 m. wide and deep openings, identical with the two central ones that remain the same, as originally planned. There will thus be four of these deep or flush controller openings, each fitted with double gates. The total length of the weir, Fig. 22, is now, consequently, some 14·50 m. shorter than previously, with the left abutment projecting into the Shannon by a corresponding amount. The superstructure housing the machinery for operating the gates and running from top to top of the piers has also been changed from a reinforced concrete to a steel one. The general design of the fish pass has, moreover, been revised in order to give the best possible conditions for the fish.

After the building of section I. of the weir had been completed, the building of section II. was begun and the cofferdam for the latter was completed and pumped out

FIG. 18—GENERAL VIEW OF MODEL "A"

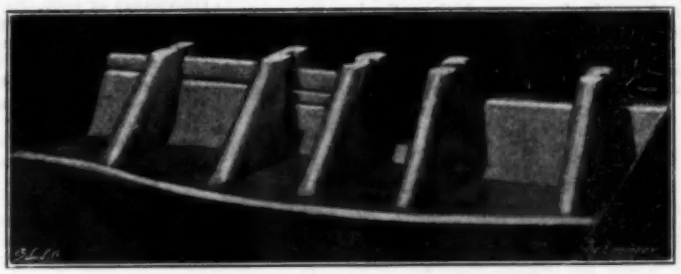


FIG. 19—GENERAL VIEW OF MODEL "D"

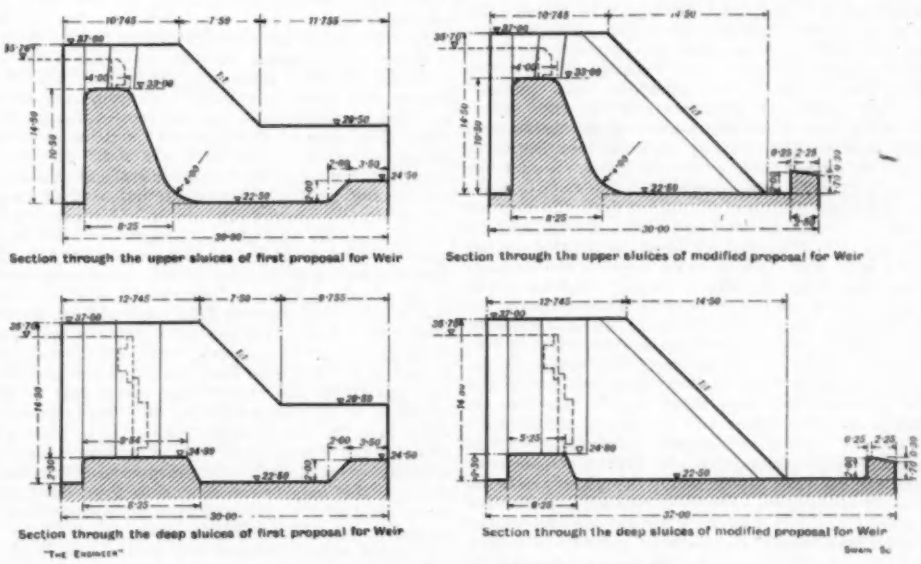

Section through the upper sluices of first proposal for Weir
Section through the upper sluices of modified proposal for Weir
Section through the deep sluices of first proposal for Weir
Section through the deep sluices of modified proposal for Weir
"THE ENGINEER"

FIG. 21—SECTIONS THROUGH WEIR SLUICES

by the end of June, 1928. This section comprised the whole of the left abutment of the weir with its fish pass, the first two 10 m. wide flush controller openings with their two piers, each pier being 4·50 m. wide. The cofferdam adopted for this section differed considerably from the type used for the first section. It was much narrower, measuring only 2 m. from inside to inside of the vertical row of I joists, and was concreted instead of being filled with earth, the total working space it afforded amounted to some 1950 square metres, as compared with 1300 square metres in the case of section I. This type of construction proved extremely efficient and satisfactory; in fact, on account of the considerable difficulties experienced with the foundations, there is little doubt that an earth-filled cofferdam would hardly have stood the extremely trying conditions. The difficulties with the foundations were due to the fact that in some spots the solid rock bed proved to be much deeper than first anticipated, and, furthermore, was covered by a layer of soft material with hard rock on top. On this top layer some portions of the cofferdam were built, with the result that, in order to prevent bad percolation underneath the cofferdam through the soft strata, it had to be strengthened in places from outside by another concrete-filled cofferdam extending down to the solid rock bed. When this strengthening work was completed, the cofferdam itself proved sufficiently watertight. Most of the water that leaked in came through the fissures in the rock below the cofferdam, as in building section I., although the rock foundation was carefully cement grouted under a pressure of six atmospheres. The working space was, however, kept quite dry by pumps working continuously.

For about a fortnight at the end of November and beginning of December, 1928, the Shannon was in an exceptionally high flood, and the work inside the cofferdam had to be interrupted. When the water level was back to normal, the cofferdam was pumped dry again, no damage whatever having been done to it.

The excavation work for the piers, spillway, left abutment, &c., was chiefly done by a small 0·80 cubic metre steam shovel on caterpillars, while the minor

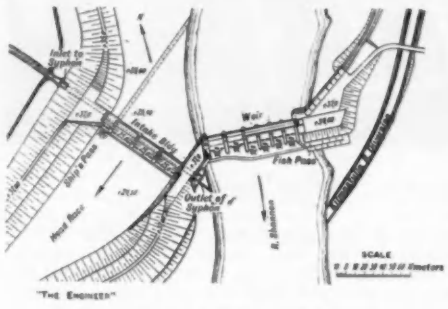


FIG. 22—WEIR AND INTAKE BUILDING

excavations and excavation in places inaccessible for the steam shovel were made by hand and cable crane. The material removed by the steam shovel was hauled up to the left Shannon bank by an inclined elevator and subsequently used to strengthen the toe of the new bank between the Kilmastulla River diversion and the Shannon. The material was conveyed from the elevator to the bank by a narrow-gauge railway. The excavation work was begun immediately the cofferdam was pumped dry, the necessary strengthening of the cofferdam being carried out simultaneously so that no time might be lost. The abutment and the pier nearest to it were concreted first, while the foundation for the second pier were being prepared. The rock foundation under the piers and sills of the openings between them was cement grouted to a depth of 5 m., and the upstream side of the left abutment to depths varying from 4 m. to 3 m. The distance between the grouting holes was on the average 2·30 m., the holes being spaced in two rows 1 m. apart. The cement grout was injected under a pressure of six atmospheres, the grouting being necessary in order to prevent percolation under the weir through the fissures in the rock foundation. The spillway and the top of the sills between the piers were granite faced to an average depth of about 50 cm. The granite blocks on top of the sills required particularly careful anchoring and placing, as the rush of water over them will be very severe when the gates are being lifted. Furthermore, in order to minimise the friction of water rushing over them, their surface was dressed in a special manner. For the most part the concreting work was done directly by the cable crane, but partly by a special tower and chute arrangement. The work was carried out without interruption, except when frosty weather prevailed, for concreting was stopped when the temperature dropped to 32 deg. Fah.

The gates between the piers consist of upper and lower portions, and are of the steel lattice type, their combined depth amounting to 10·90 m. The work inside the cofferdam was completed by the end of January, 1928. It was then flooded and blasted up in sections, the *débris* being removed by a grab excavator on pontoons.

The fish pass, which is one of the largest in the world, is some 190 m. long, and consists essentially of a series of steps with stop walls at the end, forming pools. The drop between each step was on the average 50 cm. Each pool is 7 m. long by 3 m. to 4 m. wide. Three rest pools of lengths up to 20 m. have also been provided. The supply of water will be regulated by a series of small gates measuring 1·50 m. by 2·00 m., arranged in the upstream wing wall of the left abutment behind which the fish pass is situated.

At the present time the fish pass, the steel superstructure and the last cofferdam for the remaining two piers are being completed.

(To be continued.)

The Past and Future of Iron.*

THE changes which this half-century have wrought in the manufacture of iron and steel would of themselves present a fascinating theme, but I propose to-day, with your permission, to take a much wider range, and to put before you a short summary of the history of iron manufacture from its very beginning, viewed in the special light in which I venture to regard it—namely, as a consequence and corollary of the ever-increasing power which mankind gradually learnt to exercise over the production of heat. I hope to be able to show that the history of iron and the history of heat generation have gone hand-in-hand throughout the ages, and that the former has been absolutely dependent upon the latter.

The date and even the place of the first use of iron by mankind have never been determined; it appears to be generally held that it was first produced in workable quantity on the southern flanks of the Caucasus, and the date assigned is usually somewhere about 3000 B.C., though for my purpose both the place and the exact or even the approximate date are matters of but secondary importance. It is at any rate certain that, before iron came into use, the metallurgy of bronze was already highly developed. Articles of bronze of the Later Bronze Age show that the art of bronze-founding had already reached a high stage of perfection. The art of making cored castings was undoubtedly known, and it seems probable that even the *cire perdue* process had been invented. No doubt the simple reduction of metallic iron from its ores would have been well within the capabilities of these primitive metallurgists, but from the simple reduction of the metal to its fashioning into any useful form is quite a far step. Oxide of iron is reducible to the metallic state at a very low temperature, not exceeding 500 deg. Cent., but the iron so produced is more or less pulverulent and useless for all practical purposes. To weld it into a coherent mass capable of useful application requires not only a considerably higher temperature, but for articles of any size a considerable body of heat. The only information that we have as to the early means of producing the necessary heat is derived from Egyptian mural paintings. It is significant that all the earlier ones—for instance, one from the frescoes of Beni-Hassan, said to date from about 2500 B.C.—show men blowing up a fire beneath a crucible by means of mouth blowpipes made of reed and tipped with clay, and it is evident that with such rudimentary appliances only very small pieces of iron could be produced. In corroboration, it may be pointed out that at these very early times iron was evidently looked upon as a scarce and valuable substance; in the Swiss lake dwellings, and at Hallstatt, in Austria, articles of bronze have been found inlaid with iron, thus indicating that the latter metal was the more valuable of the two. The date of the Hallstatt articles is usually given as between 1000 and 875 B.C. The Crown Prince of Sweden in his recent excavations at Nauplia, on the Bay of Tolon, Greece, found a silver ring in which was set a seal made of iron; this was found in a tomb together with a bronze dagger and other bronze articles, the date assigned being about 1100 B.C. The first known representation of any mechanical means for producing a blast is from the walls of a tomb of the period of Thothmes III., supposed to be from about 1500 B.C. This primitive bellows apparently consists of a flat pot covered with skin, in the centre of which is cut a hold that can be closed at will by the heel of the operator, which thus forms a valve, the skin, when released by the heel, being pulled up by a cord in the worker's hand. It is interesting to note that this identical type of bellows is still used in India by certain tribes for the purpose of iron manufacture, the only improvement in over 3000 years being the use of a couple of light bamboos which act as springs to pull up the hide cover.

Various other forms of bellows are also in use in different parts of India. I am aware that some authorities maintain that iron was used in Egypt for industrial purposes before 2500 B.C., but even if this were correct, it would be only in quite small pieces. In any case I would suggest that it could not have been much used before some means of readily producing the required blast had been devised; so far, all that can be said definitely is that such invention must have been prior to 1500 B.C., but no one can say how much earlier, though it does appear probable that it may have taken place between the years 2500 B.C. and 1500 B.C.

The essential point which I want to bring out is that the means of generating the requisite heat must have been the controlling condition in the manufacture of iron. Furthermore, as is well known, whilst iron reduced at a low temperature, even from impure ores, is sufficiently pure not to be brittle, it must necessarily be very soft, and it may readily be supposed that a well-made bronze sword was for quite a while superior to a soft iron one. This difficulty must have persisted until a much later date in Northern Europe, since the Norwegian Sagas more than once record that a warrior had a sword so soft that he had to stop to straighten it underfoot in the course of the conflict. It would appear to be probable that a good deal of the earlier iron made in Northern Germany and Scandinavia must have been reduced from bog iron ores; these ores are usually high in phosphorus, and the reduction must have taken place at quite a low temperature and, therefore, have produced a very soft iron.

On the other hand, it is quite certain that in the countries bordering on the Mediterranean, where the knowledge of metallurgy was much older and civilisation was much further advanced, temperatures high enough to cause some carbon to combine with the iron and thus make relatively low carbon steel or steely iron had been attained at a very much earlier date, as is evident from the oft-quoted passage in Homer's Odyssey; from which it is obvious that steel or steely iron capable of being hardened by quenching was known in Homer's time, though the carbon content could not have been excessive, seeing that the metal so treated was not too brittle to prevent its being used as an axe.

It could, however, not have been very long after the beginning of our era before, with the employment of larger furnaces and, therefore, the production of a greater body of heat, a true steel was produced, and this would, of course, be the case more readily when manganiferous ores happened to be employed instead of ordinary iron ores. It must be remembered that the above statements as to the use of iron refer only to the region which at that early date was the centre of human civilisation; it is generally held that iron was not introduced into Britain until 500 B.C., and that its manufacture did not commence in these islands until about a century later.

Before Cæsar's invasion, iron was certainly being made in the South of England, though the Brigantes in the North appear still to have been in a Stone Age. Before Cæsar's time, iron currency bars were in use in Southern Britain—a fact which would seem to imply that, although iron was being made, it was still scarce and comparatively valuable. After Britain had become a Roman province, iron was made at numerous places in this country, most actively perhaps in the Forest of Dean, though there were various other important centres of early Roman iron production. The manufacture of iron continued in this country throughout the Roman occupation. The largest mass of Roman iron found in this country, if not in the world, is the mass discovered at Corstopitum, near Corbridge, in Northumberland, described by Sir Hugh Bell.† Its date is considered to be between A.D. 350 and 380, and its weight was about 3 cwt. It is interesting to note that the famous iron pillar of Kutub, near Delhi, dates from about the same period or a little earlier, but weighs no less than some 6 tons, so that at that date the Eastern iron makers were far ahead of their Western contemporaries. There is, however, no doubt that both of these masses of iron were produced by the same method, that of making relatively small lumps of iron by the direct process and welding them together. It is quite clear that the method of iron production throughout all this period was always the same—namely, direct reduction by charcoal in furnaces probably not more than 3ft. or 4ft. high, and blown by bellows worked by manpower, in which the temperature was only high enough to produce soft malleable iron, or, at the best, with suitable ores a steely iron or a steel. Apparently, this method of ironmaking must have continued during the next thousand years or so; probably furnaces were steadily increasing in size, larger lumps of iron were being made, and probably steely iron or even steel was produced at will. The art of letting down or tempering steel must also have been discovered, and the technique of iron working, as distinct from the extraction of iron, made immense strides.

An invention that must have contributed no little to the increase in the size and power of the mediæval furnace was that of mechanical blast production. Agricola, whose well-known work is dated 1556, though he himself died in the previous year, figures and describes in much detail the construction of a bellows with valves of quite modern type, worked by a water-wheel, and it is obvious from his description that the appliance was old enough for its details to have become standardised. It is on record that such bellows were in use at Göllnicz in 1435. A natural result of the increase in the height and power of the furnace and of the attendant higher heats thus generated was the production of white cast iron, and it is tolerably clear from Agricola's writings that this was known in his day. No doubt this unexpected result of the higher furnace temperature must have been a disagreeable surprise to the early metallurgist,

* Iron and Steel Institute. Presidential address by Professor Henry Louis, D.Sc., &c., Thursday, May 2nd. Abridged.

† *Journal* of the Iron and Steel Institute, 1912, No. I., p. 118.

who found in his furnace a lump of this hard, brittle, useless material instead of the mass of malleable iron or steel which he hoped to produce. In the course of time, however, he would discover that this useless metal could have its pristine malleability restored to it, or, as he expressed it, the iron could be "freshened" by heating it in another (or possibly the same) furnace. This step would lead to a still further increase in furnace and bellows capacity, and this in turn would bring about a further increase in furnace temperatures with the again unexpected result of producing grey cast iron, as soon as the temperature became high enough to reduce some silicon. It would soon be found that such iron ran very fluid and was admirably adapted for making castings. Apparently one of the very earliest forms of iron castings was the iron stove plate, which originated in Germany. A sketch is known, from which a stove plate was evidently intended to be cast, dated 1474, in Nassau, though the plate itself has not been found. The oldest known cast iron stove plate is dated 1497, and was from the Eifel, which appears to have been one of the earliest centres at which castings of this kind were made.

The next stage was the production of mild steel in the Bessemer converter and the Siemens open-hearth furnace, to be followed by the important modification of Thomas and Gilchrist, which we know as the basic process. Necessarily, these processes involved the use of still higher temperatures than had hitherto been attained, and finally we reach the production of alloy steels in the electric furnace with its capacity for generating still higher temperatures.

One interesting fact emerges from this review—namely, that each successive metallurgical advance has been attended by a deterioration in quality of the product (except in cases when an entirely new material has resulted), though each has been accompanied by such an increase in quantity of output as to more than compensate for the inferior quality, by placing increasing quantities of iron at the service of mankind. It is only necessary to compare the blast-furnace of 1750, which, according to the records of the time, was doing excellent work when it produced 24 tons per week, with the modern furnace which smelts that quantity in about half an hour. On the other hand, it is undeniable that puddled iron is inferior to iron made by the direct process, that coke pig iron is inferior to charcoal pig, and that hot-blast pig iron is not as good as cold-blast pig. Again, whilst structural steel was in one sense an entirely new material, from another point of view it is not unfair to say that it is an inferior material to the older crucible steel. Nevertheless, it is also undeniable that the world is distinctly the richer for having at its command the huge quantities of iron and steel that were quite unthinkable even a century ago.

It will, I hope, be admitted that this rapid review of the history of iron manufacture is correct, at any rate in its main features, and that my contention, that the power to produce high heats has throughout been the controlling factor, is well founded; I want to make it clear that I consider that the various stages of iron manufacture and of the generation of ever higher temperatures are not two independent concurrent parallel lines along which the development of human civilisation has travelled, but that they are distinctly related as cause and effect. This being true of the past, what can we say as to the future? Just as there is a lower heat limit below which iron capable of being usefully applied in the arts could not be produced, so there must be an upper limit, and I suggest that this limit is reached when our furnaces are capable of generating a temperature sufficient to volatilise the iron; it seems fairly obvious that heats higher than this cannot well be usefully employed. Such heats are, however, now readily attained in the electric furnace, and it would, therefore, seem that from this point of view the limiting condition has already been reached by the metallurgist. On the other hand, there seems but little inducement to increase the quantity of output, seeing that our potentialities of production appear to be now actually ahead of the world's requirements, and that there is every indication that even our present appliances will enable us to keep pace with any future demands.

I emphatically do not mean to imply that we have reached finality in the metallurgy of iron, but I do hold that future progress will have to be along different lines. Fortunately, we are already able to see what direction this progress must take. Recent advances have all been in the direction of improvement in quality and in the attainment of properties in which ordinary iron by itself is deficient, such as we have already obtained by the use of alloy steels, of which Sir Robert Hadfield may well claim to be one of the pioneers. In other words, the future of the metallurgy of our metal will be directed, not by the crude methods of trial and error of the past, but by the application of principles developed by the methods of scientific research.

ANSWERING a question addressed to him recently, the Minister of Transport said that there was no record as to the number of level crossings in Great Britain; there are, however, 250 of more than ordinary importance. Since 1923–24 sixteen schemes, for the abolition of twenty crossings, had been approved in grants from the Road Fund.

The Hudson River Bridge.

THE "Second Progress Report" on the condition at the beginning of this year of the Hudson River Bridge, which is being built at New York between Fort Washington and Fort Lee, has recently been made public by the Port of New York Authority. In our issue of April 20th, 1928, we gave a lengthy summary of the "First Progress Report," which dealt with the condition of the bridge at the end of the year 1927. We propose, in what follows, to deal in like manner with the present publication, which, as was the first Report, is from the pen of Mr. O. H. Ammann, Chief Engineer of Bridges to the Authority, and is prefaced by a short introduction written by Mr. J. E. Ramsey, the Authority's Chief Executive Officer. We quote, to a considerable extent, verbatim from the Report.

Our readers will remember that this cable suspension bridge is being built by the Port of New York Authority, which is a body created by a compact made between the States of New York and New Jersey, and ratified by Congress. The position occupied by the structure is shown on the accompanying map—Fig. 1—and it is particularly noteworthy in that the bridge is to have a span of no less

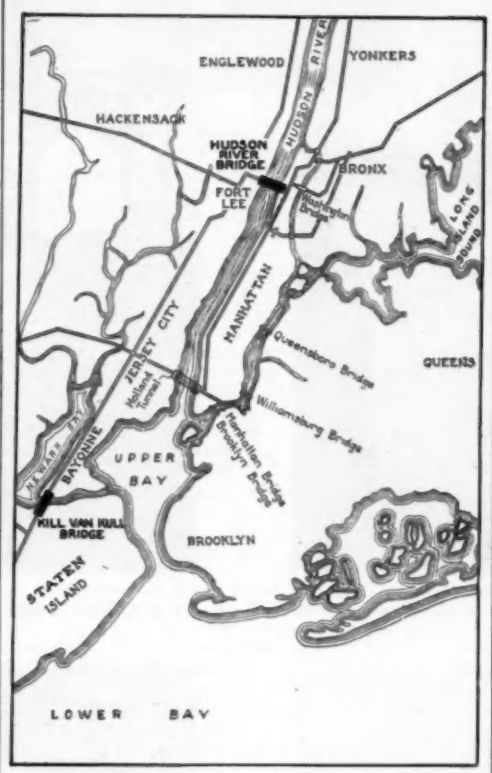


FIG. 1—MAP SHOWING SITE OF HUDSON RIVER BRIDGE.

than 3500ft., the total length with the side spans and approaches being 7800ft. Moreover, the height of the towers supporting the cables is as great as 635ft. A profile, plan, and cross section of the bridge, as it will appear when completed, were given in our issue above referred to, as were also drawings of the tower structure and of the New York and New Jersey anchorages, and it will not be necessary to repeat them in the present instance.

We learn from the first portion of the Report that very substantial and satisfactory progress was made with the works during last year. Early in the year the unusual and difficult foundation work for the New Jersey tower, which had been under way since the summer of 1927, was brought to successful completion in time for the scheduled erection of the steel tower. A contract for the construction of the tower base on the New York side—which was a comparatively simple operation of building two huge concrete blocks on rock above water—was awarded in May, and the work was completed within two months.

The rolling of steel for the two towers, which ran to 40,000 tons, began late in 1927, and throughout last year, fabrication of the steel work proceeded continuously at three of the largest bridge shops in the country. The erection of the towers was begun in June last, and such rapid progress was made, that within four and a-half months, 31,000 tons of steel had been got into position and the towers had reached a height of 500ft.—or about five-sixths of their total height. Operations in this department were then discontinued, as it was not thought desirable to permit men to work in the open at such a height during the winter months. Fabrication work was, however, carried on uninterruptedly so that the material might be ready when work was resumed in the early spring.

While the construction of the towers was going forward, work on the anchorages was being actively pursued. Since the summer of 1927, and throughout the whole of 1928, the excavation of 200,000 cubic yards of hard trap rock for the New Jersey anchorage and approach progressed steadily, and by the end of last year it was practically completed. On May 4th, 1928, a contract was entered into for the excavation for and the building of the enormous blocks of masonry which form part of the New York anchorage in Washington Park, and which involve the placing of approximately 110,000 cubic yards of concrete. Excavation for this anchorage was started last summer, and so efficiently did the work and the concreting progress that at the close of the year both were very nearly finished—several months ahead of the stipulated time. The steel anchorage and anchor chains for the cables, which formed part of the cable contract, were got into position and solidly embedded as the work of building up the concrete anchorage block on the New York side proceeded. By the end of the year, the steel anchorage on the New Jersey side was being erected in tunnels excavated in rock.

Fabrication of the 29,000 tons of high-tension steel wire for the four cables was begun in February, 1928, and by the end of December one-third of the total quantity had been produced. The contractor, says the Report, has made elaborate preparations for the spinning of the cables in place, which is due to begin this summer.

The Report then goes on to discuss:—(*a*) Studies of traffic and revenue; (*b*) design studies, working plans, and specifications; (*c*) studies of approaches and highway connections; (*d*) inspection, testing and research work; and (*e*) the acquisition of property, which we need do no more than mention, and it then passes on to give particulars of construction work. By the end of 1927, the two large cofferdams for the New Jersey Tower foundation had been completed, and the placing of concrete in them had been started. The work of building these cofferdams and the excavation to rock was described in the first Report, but the following brief reference to it may be given here. The silt overlying the rock was first dredged out to a uniform depth of about 45ft. below the surface of the water and timber frames, against which the steel sheet piling, which was to be driven to rock, might be supported, were sunk. In the deeper portions of the cofferdams the sheet piling formed double walls, separated by cross walls forming pockets into which, as the case required, either concrete, sand, or silt was deposited. In the shallow portions of the cofferdams, in which the hydrostatic pressure was less, only a single wall of sheet steel piling was used. After the cofferdams were unwatered, excavation was started in the shallow portions, and, as soon as a considerable area of the rock foundation was exposed concreting was started and carried to such an elevation as to encase the lower three timbers of the frames. In that manner excavation and concreting proceeded step by step from the shallower to the deeper portions, the concrete in each step being brought up to, approximately, the same elevation.

When the overburden was removed, the rock was found to be throughout of solid sandstone of varied degrees of hardness and texture, and of very rugged surface. This, as the Report remarks, was a most fortunate condition, because the natural steps or benches formed an excellent bond with the concrete, so that little or no blasting of rock was required. The soft overburden of silt was, in large part, removed hydraulically by flushing it to centrifugal pumps which had been provided to unwater the cofferdams and to keep them dry. The seepage into both cofferdams, it is explained, was so light that the pumps had ample capacity for removing the silt in this manner. Directly above the rock, a stratum containing shells, boulders and disintegrated material was found. This stratum was removed by being loaded by hand into skips or buckets, which were hoisted out of the cofferdams by derricks and deposited outside. After all the excavation had been completed and the concrete over the entire area of the pier had been poured to such a level as to encase the lower three frames of timber, the operation was carried on continuously, all further timbers being removed as the work proceeded. The granite facing was begun about 9ft. below the water level, and, thereafter, all the concrete was poured, course by course, with the granite facing. The contract for this work was entered into in May, 1927, and was completed and accepted in June, 1928. The operations involved 75,500 cubic yards of dredging, the placing of 35,480 cubic yards of concrete, 1400 cubic yards of granite, and 300 tons of reinforcing steel. The total cost was 1,058,700 dollars.

The New Jersey approach consists, essentially, of an open cut through the Palisades, and the anchorages of the cables on that side extend 250ft. into solid and hard trap rock formation. The roadway of the upper floor of the bridge intersects the rock face of the Palisades about 50ft. below the top of the latter, and the lower floor is about 35ft. below the upper one. Below the lower level and at the head of the inclined tunnels or shafts, in which the anchorages for the cables will be built, are the anchorage pits, 75ft. deep, in which the sixty-one strands of each of the four cables will be splayed out and fastened to the steel eye bars which will connect the cables with the anchorage girders arranged at the bottom of the

shafts. The eye bars, chains and anchorage girders are to be embedded in concrete, which will completely fill the anchorage tunnels or shafts after the anchorages are erected. West of the anchorage pits, the cut is to be excavated, for the present, only to the depth of the upper roadway. When the lower roadway on the bridge is constructed, the additional excavation for its extension under the approach roadway can be made, without interruption to traffic, either by open cuts methods or by tunnelling. Throughout its length of 750ft. this rock cut will be 146ft. wide at roadway level, and, when complete, it will have involved the removal of, approximately, 220,000 cubic yards of rock.

The contract for this rock excavation was entered into in June, 1927. On account of the extreme hardness of the rock, it was necessary to resort to special methods of blasting, including the use of 8in. well drills, instead of the smaller tripod drills ordinarily used. In all, four such drilling machines were used. The large hole with the entire charge of dynamite concentrated at its bottom proved very effective. After blasting, the large pieces of rock were broken up, when necessary, by cast steel "skull crackers." In some cases the larger pieces had to be further drilled and blasted. On account of the magnitude of the operations, the contractor installed a complete compressor plant, a blacksmith's shop, a drill-sharpening plant, &c. The work was begun by first stripping off the overburden of dirt from the entire area to be excavated. Power shovels then started to excavate a narrow cut in the rock from Hudson Terrace East. While this work was going on, a vertical shaft, 7ft. by 9ft. in cross section and 250ft. deep, was sunk at a point just north of the extreme northerly edge of the cut, and west of the extreme westerly end of the anchorage tunnels. From the bottom of this shaft a horizontal drift was run to the south, somewhat beyond the southerly anchorage tunnel, and from this drift the excavation of the tunnels was carried on from the bottom up. This method offered two principal advantages :—First, it enabled the contractor to work simultaneously and without interference, in the cut, anchorage pits and tunnels, and, secondly, it permitted the loading of all material blasted from the tunnels by gravity into trolleys, which travelled in turn, by gravity, to the shaft, up which they were hoisted to a trestle on the top of the Palisades, and on that hauled to the crusher plant. The contract required that all the work should be completed by January 1st, 1930, but, actually, by the end of last year, all work in the tunnels, anchorage pits, and in the approach cut was finished, except for cleaning up and the removal of plant.

The New York tower foundation rests upon the rocky point at Jeffrey's Hook Light in Fort Washington Park. It consists of two piers or bases, one under each leg of the tower, 153ft. from centre to centre. Each base, as now constructed, measures 68ft. by 76ft. 6in., but will be increased to 76ft. by 84ft. 6in., when the granite facing, which was omitted to expedite the building of the bases, is added. The rocky point on which the piers are built is of such configuration that each base extends, in part, beyond the shore line. Shallow simple cofferdams were, however, sufficient to exclude the water. The rock encountered was typical Manhattan schist, very markedly stratified. The excavation revealed that disintegration of the rock had followed the seams to such a depth that 85 per cent. more rock than had been anticipated, had to be excavated. So expeditiously was the work carried out, however, that though the contract was only entered into early in May, it was possible to start the erection of the steel tower on July 1st.

While engaged on this work the contractor was also constructing his plant, making the excavation and doing the preparatory work for the construction of the anchorage block in Fort Washington Park just west of Riverside Drive. This anchorage will eventually represent a masonry block measuring about 200ft. wide and 290ft. long at its base, and 130ft. high, and will rest on solid bed rock. It will be built in two stages. In the first stage all granite facing and some concrete backing is being omitted, as are also some of the upper portions of the masonry, only such portions being constructed as are necessary to permit of the erection of the cables and their anchorages embedded in the concrete.

The 976 eyebars and the twenty heavy girders to which the eyebars are fastened, all forming the anchorage steel work, were furnished and delivered to the site by the contractor for the cables and anchorage steel work, but the contractor for the anchorage masonry was required to set this steel in place. To do so the concrete was poured to a height well above the ground level, leaving pits into which the steel framework was set. Steel frames supported the eyebars accurately in their proper positions. After all the steel work had been set and adjusted concreting was begun, and each pit was filled in one continuous operation so as to avoid construction

FIG. 2—NEW JERSEY TOWER, NOVEMBER 10TH, 1928

FIG. 3—NEW YORK TOWER AND ANCHORAGE, NOVEMBER 22ND, 1928

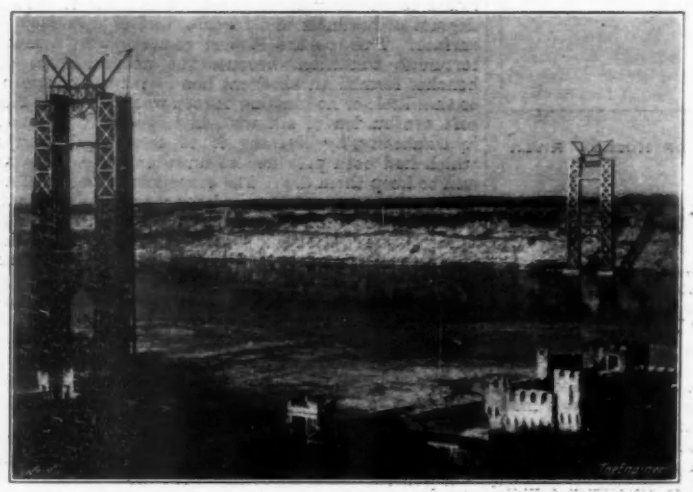


FIG. 4—VIEW OF TWO TOWERS AND RIVER, NOVEMBER 12TH, 1928

FIG. 5—AERIAL VIEW OF NEW YORK ANCHORAGE, DECEMBER 22ND, 1928

joints. Great care, says the Report, was taken in all the concreting in this anchorage, and particularly in the concrete which surrounds the anchorage steel work, so to proportion the aggregates and thoroughly mix them as to obtain an impervious mass. As a further protection against corrosion all the steel work in the anchorage was given three heavy coats of red lead paint.

The contract involved approximately 7300 cubic yards of rock excavation, and the placing of 9700 cubic yards of concrete in the tower foundation; 16,000 cubic yards of excavation and 110,000 cubic yards of concrete in the anchorage; and the setting of about 2500 tons of anchorage steel work. In addition, some 500 tons of reinforcing rods will be used. The total estimated cost is 1,150,000 dollars.

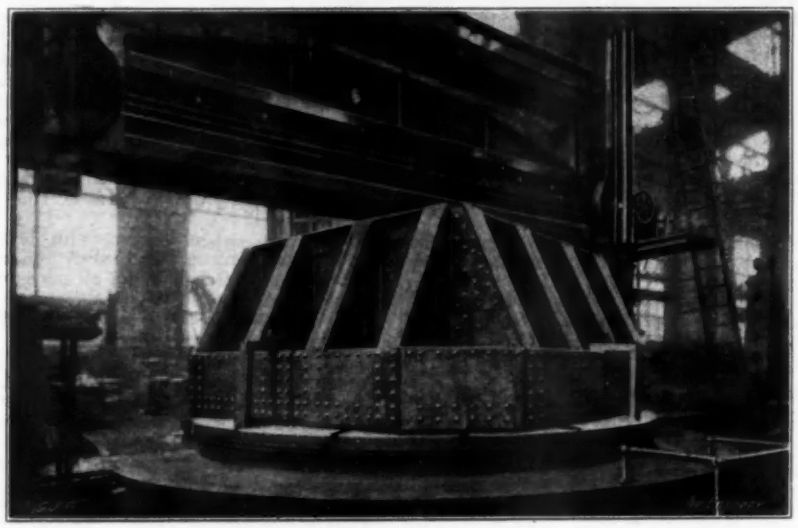


FIG. 6—PLANING COLUMN BASE IN MAKERS' SHOP

The towers, each of which carries at the top a load of 112,500 tons from the cables, consist of steel frames 556ft. 6in. high, which, later, are to be encased in concrete and granite masonry. Each tower has sixteen columns of silicon steel arranged in two groups of eight columns each, one group being under each pair of cables. Each group of columns, or leg of the tower, is formed into a rigid structure by bracing between the columns, and the two legs are connected by arched trusses below the level of the floor and at the top. The two towers will contain over 40,000 tons of steel. Inside the steel skeleton of each tower there are to be two elevators to give access to all parts of the tower shafts for observation and maintenance. The order for the fabrication and erection of the towers was placed with the McClintic-Marshall Company. In order that the fabrication of the towers might progress with sufficient rapidity, the contractor sublet to the Bethlehem Steel Company the fabrication of the lower half of the New Jersey tower and to the American Bridge Company that of the lower half of the New York tower. The McClintic-Marshall Company retained the fabrication of the upper parts of both towers.

In connection with the erection of these towers the Report says:—"It is essential that the tops of the columns in each leg of each tower shall be at the same elevation so that the saddles which support the cables shall have an even and uniform bearing upon them. To accomplish this it was considered necessary to stop erection on both towers after ten panels had been erected, in order that accurate measurements might be taken and adjustments made in the length of the individual columns between the tenth panel and the top of the tower. So accurate was the work, however, that the maximum difference in length between the highest and the lowest column in any of the four legs of the two towers was only three-sixteenths of an inch and, in verticality, the variations were negligible. When it is considered that these results were obtained after the erection of over 15,000 tons of steel in each tower to a height of approximately 500ft., the precision of the work is apparent. Correction, however, is being made even of the small difference in height of columns as found."

FIG. 7—NEW YORK ANCHORAGE, NOVEMBER 22ND, 1928

The design of the bridge provides for four parallel wire cables, two on each side of the bridge, extending from anchorage to anchorage over cast steel saddles at the abutments and at the tops of the towers. In each cable there will be 26,474 double galvanised high strength steel wires, each 0·192in. in diameter before galvanising. During the process of spinning or stringing, the wires in each cable will be grouped into sixty-one strands, each strand having 434 wires. When compacted and wrapped each cable will have a diameter of approximately 36in. The order for the cables, suspenders and anchorage steel work was given to the John A. Roebling's Sons Company, of Trenton, New Jersey. It includes the supply of some 29,000 tons of steel wire and 12,000 tons of structural steel and castings.

In conclusion, Mr. Ammann states that credit for the excellency of, and expediency with which, the work has so far been performed is due very largely to the efforts of all the contractors and their co-operation with the staff. In addition to those whose names have already been mentioned, the Silas Mason Company was contractor for the New Jersey foundation and tower bases; Foley Brothers, Inc., for the New Jersey anchorage and approach; and the Arthur McMullen Company for the New York anchorage and tower and foundations.

The Report is illustrated by means of drawings and a series of half-tone engravings, of which a selection has been reproduced herewith and on page 490. Fig. 2 shows the New Jersey tower ready for the erection of the last two panels. The traveller and riveting scaffolds are to be noted. The horizontal strut seen under the traveller is only a temporary erection. Fig. 3 shows the New York tower and anchorage as it was on November 22nd, 1928. The concrete distribution plant is observable in the centre of the picture. Fig. 4 is a view of the bridge towers looking towards the Palisades, while Fig. 5 is a reproduction of an aerial photograph of New York and its anchorage taken on December 22nd, 1928. In Fig. 6 one of the tower column bases is seen being planed in the makers' shop. A single base is about 14ft. square, 6ft. high, and weighs about 60 tons. Fig. 7 shows the New York anchorage, the photograph having been taken on November 22nd, 1928. The wire cables will be attached to the steel anchorage, which will be completely buried in the anchorage masonry.

Of the four views on page 420 Fig. 8 shows the New Jersey Pier foundation, showing the cofferdam and construction plant. Fig. 9 shows the bases and bottom sections of the tower with the columns in place. In Fig. 10 the erection traveller is seen in the first position, placing the lower column bases, the view having been taken in June, 1928. The electric hoisting engines are housed in the shed at the left of the picture. The erection of the New Jersey tower is seen in Fig. 11. When all eight inside columns and bracing have been erected, as seen on the left, the traveller is raised to its next higher position.

The Kelvin Lecture.

ALTHOUGH Dr. G. C. Simpson's Kelvin Lecture on Lightning, delivered before the Institution of Electrical Engineers on Thursday of last week, was mainly devoted to an explanation of lightning discharges, it aroused very great interest. That the generally accepted theory of lightning is wholly incorrect, the lecturer endeavoured to prove, but the most useful parts of the lecture from the practical engineer's point of view were, in our opinion, those relating to the characteristics of lightning. The question of whether a lightning discharge is unidirectional or oscillatory has now been finally settled by means of the cathode ray oscillograph, which has shown that the main discharge in a lightning flash consists of a unidirectional current, which starts from zero, rises to a maximum and then decreases more or less rapidly to zero again. In the light of the theory of lightning set forth by Dr. Simpson, who maintains that clouds are practically perfect non-conductors, this is easily understandable, for the essential of an oscillating discharge is a condenser which on discharging overshoots the mark, thus causing a return current, which recharges the condenser. As long as the cloud was considered to be a conductor which could be discharged like a Leyden jar, it was natural to conclude that lightning would be oscillatory. But it is now known that a cloud is practically a perfect non-conductor, and as it has no capacity, it cannot act in the same way as a Leyden jar. There is, however, another factor to be taken into account.

Although, as a whole, a cloud has no capacity, the conducting channel, when once it has been formed, has capacity and self-induction; in fact, the channel of a lightning flash can be regarded as a gigantic wireless aerial, and if its resistance is not too great, it will oscillate like any other wireless aerial. The effect is somewhat similar to that of a singing arc, in which the conducting path through the air between the electrodes is maintained by a unidirectional current, whilst the oscillations which give rise to the musical note are superimposed upon this current, according to the natural frequency of the circuit. If, as Professor Appleton suggests, atmospherics owe their origin mainly to lightning discharges, the ripples find their natural explanation in the oscillations within the lightning channel.

It is important in all practical problems to know the magnitude of the electrical factors involved, and with that point the lecturer also dealt. The quantity of electricity discharged in an average lightning flash varies between 10 and 50 coulombs, and 20 coulombs may be considered to be typical, a quantity of electricity which would appear to be too insignificant to call for the consideration of electrical engineers. It has been estimated, however, that the potential reached in a thunder cloud, before the passage of a discharge of 20 coulombs, is in the neighbourhood of a thousand million volts, although, needless to say, potentials of this nature are never reached at the earth's surface when a body is struck. The resistance of the air channel reduces the voltage, but there is no reason why potentials of tens of millions of volts should not be reached when conductors, such as transmission lines—which are not directly connected to earth—receive a direct stroke.

The energy associated with a discharge can be calculated directly from the quantity of electricity and the voltage, and it works out at 10^{17} ergs for a flash discharging 20 coulombs. Expressed in more familiar units, the energy dissipated in an average lightning discharge is in the neighbourhood of 3000 kilowatt-hours. Whilst much of this energy is naturally absorbed in the channel, the most powerful strokes deliver a large proportion of their energy to the earth. All determinations of the time element agree in making the average duration of a lightning

discharge greater than one-thousandth of a second. A discharge of 20 coulombs in a thousandth of a second gives a mean current of 20,000 ampères, but this mean value must be greatly exceeded for short periods during the course of a discharge, and instantaneous values in the neighbourhood of 100,000 ampères are suspected.

Now that it is known that a lightning discharge is unidirectional, the problem of arriving at the size of a conductor necessary to convey the most powerful lightning discharge safely to earth resolves itself into calculating the rise of temperature due to the passage of a known quantity of electricity in a given time. The calculation shows that the most violent discharge that is likely to occur will be safely carried by a copper conductor having a cross-sectional area of 0·08 square inch, or an iron conductor of 0·2 square inch section. Both these values are less than those recommended by the Lightning Rod Conference of 1881, and in the case of copper little more than half the cross-sectional area specified for lightning conductors in all Government work in this country. The chief difficulty with lightning conductors is the resistance of bad joints or bad earths, for as the conductor may have to dispose of a current of 100,000 ampères every ohm resistance will give rise to a drop on the conductor of 100,000 volts. Thus a local resistance of a bad earth of 10 ohms will rise the potential of the conductor to a million volts, which will tend to produce side discharges of a dangerous nature, to say nothing of the heat developed at the fault.

An overhead transmission is sufficiently stout to carry the full current from a direct lightning stroke, but a telegraph line is not, and there is always a considerable risk of a telegraph wire being melted if it receives a direct stroke. The danger to a transmission line does not arise from the current, but from the voltage, for if the current from the lightning channel cannot get away there is a large proportion of the thousand million volts of the cloud available for raising the potential of the line until a flashover occurs. All engineers know the results of a direct lightning stroke, and the only question that arises is whether lightning can also produce dangerous surges by electro-static induction, as well as by the direct stroke.

It is generally held that most of the surges which trouble engineers during thunderstorms are attributable to induction, but Dr. Simpson has come to the conclusion that practically all troublesome surges are due to direct strokes, and that surges arising from induction are of little practical importance. It is easy to calculate the maximum quantity of electricity released on a line when a lightning discharge takes place near the line, and it has been found that for an average transmission line the induced charge is only about one-thousandth of the charge of a direct stroke; in fact, a copper wire one-hundredth of a square millimetre in cross section would carry the induced current without melting.

Similarly, the energy associated with an induced charge can be calculated, and it proves to be only one-millionth of the energy of a direct stroke. Finally, the induced potential can only be high if the lightning discharge is all over in a few, say, 10 micro-seconds, but it has been shown that the average duration of a lightning discharge is in the neighbourhood of one thousand micro-seconds. Thus, an induced charge has not the current, the potential, nor energy to be dangerous, and a careful study of the experiments now being made in America, particularly with the klydonograph, supports the opinion that nearly all dangerous surges are attributable to direct strokes to the line.

Extended Steam Tables.*

By PROFESSOR H. L. CALLENDAR, M.A., LL.D., F.R.S.

WITH the assistance of the British Electrical and Allied Industries Research Association, it recently became possible to make direct measurements of the total heat of both water and steam at pressures up to 4000 lb. per square inch and temperatures up to 750 deg. Fah. These included the whole of the critical region, in which no heat measurements had previously been made, and proved that the objection to the Joule-Thomson equation—namely, that it was incapable of representing the complex phenomena of the critical state—had no foundation in fact. The new experimental data proved to be quite inconsistent with the van der Waals theory, which had been universally accepted for more than fifty years, but fell naturally into line with the fundamental basis of the Joule-Thomson equation, as first applied to steam by the author in 1900.

This fatal objection having been removed, a general account of the theory and equations, as applied to the critical state, was communicated to the Royal Society in 1928,[1] and a set of skeleton steam tables, calculated from the modified equation, was forwarded to the Research Association at the same time. These tables are now published with some additional details and explanations. They are not intended to be final, but are reproduced as a basis for discussion and comparison, with the object of inviting criticisms and suggestions from other workers.

It sufficed for this purpose to calculate the numerical values of the two constants required from the observed values of H and V at the critical point without making an elaborate analysis of all the available data. If the equation was of the right type, this simple process ought to give a good fit over the whole range. The value of the small constant b was found directly in this way from the fundamental relation between H and V, namely,

$$H - B = (13/3)\,a\,P\,(V - b) + a\,b\,P \quad . \quad (1)$$

with

$$H = 997{\cdot}6$$
$$V = 0{\cdot}0607$$
$$P = 3222$$
$$B = 835{\cdot}2$$

in British units Fahrenheit at the critical point for dry saturated steam. This gave

$$b = -\,0{\cdot}00280 \text{ cubic feet per pound,}$$

which was about six times smaller than the value 0·0160 previously assumed on the basis of the van der Waals theory.

The Joule-Thomson equation was modified by using the geometrical progression

$$\frac{c}{(1 - Z^2)} = c\,(1 + Z^2 + Z^4 + \quad . \quad . \quad \&c.\text{ to } \infty)$$

to include the higher degrees of co-aggregation required by theory. Retaining the original value of c, namely, 0·4213 cubic feet per pound at 212 deg. Fah., the only new constant required was the value of k in the co-aggregation ratio

$$Z = \frac{k\,c\,P}{T}$$

This was obtained by substituting $V - b = 0{\cdot}0635$ in the equation

$$V - b = \frac{R\,T}{a\,P} - \frac{c}{(1 - Z^2)} \quad . \quad . \quad (2)$$

at the point

$$P = 3222$$
$$t = 705{\cdot}2°\text{ F.}$$
$$T = 1164{\cdot}8$$

and gave

$$k = 4{\cdot}012\text{ F.}$$

This value of k was found to give such good agreement with all the observations at high pressures that any further changes were unnecessary.

Additional confirmation of the theory was obtained by deducing the theoretical equation of saturation pressure from (1) and (2) with the aid of the original equation[2] for the total heat h of the liquid at saturation, namely,

$$h = s\,(t - 32) + \frac{v\,L}{(V - v)} \quad . \quad . \quad . \quad (3)$$

which had already been verified by direct observations of h. The resulting equation for p agreed within 0·5 deg. Fah. on the average, over the whole range from 32 deg. to 717 deg. Fah., with the observed values of the saturation pressures, and was regarded as a satisfactory verification for the immediate purpose.

Equations (1) and (2), when interpreted in accordance with the laws of thermodynamics, completely define the properties of *dry* steam, while equation (3) gives all that is required in the wet region. From these three basic relations any other equation that may be required is easily deduced by purely mathematical manipulation. Thus to find the expression for H in terms of P and T, we have merely to substitute in (1) the expression for $V - b$ from (2),

$$H - B = S_0\,T - (13/3)\,\frac{a\,c\,P}{(1 - Z^2)} + a\,b\,P \quad . \quad (4)$$

S_0 is the specific heat at zero pressure, and is taken as being equal to 13 R/3, which appears to be as nearly as possible the mean value of S_0 over the range 32 deg. to 717 deg. Fah. The variation of S_0 with temperature is about 400 times less than the variation of S with pressure over this range, and is still so uncertain that it was considered undesirable to take any account of it in a preliminary reduction, though it may have to be considered when the observations at high pressures and superheats are finally reduced.

The expression for the entropy of the liquid remains the same as in the original equations. That for the vapour is deduced from (1) and (2). The equation of saturation pressure follows immediately, as explained in the "Proceedings" of the Royal Society,[3] where the numerical values of the coefficients are given. Reference should be made to this paper for any further details with regard to the theory. Additional references with regard to the methods and apparatus employed are appended. By special request some figures and tables of observations have been added, illustrating points of special interest and difficulty.

Methods and Apparatus.—The methods employed for measuring the total heat were described and illustrated in 1925.[4] A similar description was communicated by request to an American journal.[5] Further details of the electric boilers and other accessory apparatus were given in the Howard Lectures before the Royal Society of Arts in 1926.[6] The apparatus was specially designed to eliminate trouble from leakage at high pressures, and to prevent as far as possible any contamination of the water in its passage through the boiler and superheater. The methods were all based on the principle of steady flow, which greatly facilitated the reduction and determination of the heat loss, and made it unnecessary to measure the thermal capacity of the apparatus, which is always a serious source of uncertainty in static experiments at high temperatures.

Three principal types of apparatus were employed, as follows:—

(1) A differential electric calorimeter for measuring the specific heat of steam at atmospheric pressure as required for the reduction of experiments by the throttling method at high superheats.

(2) A differential throttling calorimeter for measuring the total heat of steam at any temperature and pressure within certain limits, by throttling to atmospheric pressure and observing the temperature.

(3) A jacketed condenser, with high-pressure pocket and throttle, for directly measuring the total heat of water or steam at any pressure and temperature, by throttling to atmospheric pressure and measuring the rise of temperature of a steady flow of cooling water in the condenser.

Methods (1) and (2) had the advantage that the external heat loss could be determined at each observation. They could not be employed if either the initial or final steam was wet, and were liable to systematic errors in the neighbourhood of saturation. Method (3) had the advantage of being equally applicable to water and wet steam, and of being independent of any assumption with regard to the specific heat of steam. It required, however, a very exact knowledge of the variation of the specific heat of water at ordinary temperatures, which had previously been determined with this object by two independent methods.[7]

The extended tables start at 200 deg. Cent. and 400 deg. Fah., as they agree so closely with the old tables below this point that it was not necessary to repeat the calculations.[8]

The small differences at 200 deg. Cent. from the old tables are due almost entirely to the new determination of the small constant b, which has now been determined by experiments at the critical point, whereas it could not be determined satisfactorily from the old observations at low pressures.

* Being Report Ref. J/T 40 received from the British Electrical and Allied Industries Research Association, and published by the Institution of Mechanical Engineers.—Abstract.

[1] "Proc." Roy. Soc., 1928, Vol. CXX., page 460.

[2] "Phil. Trans." Roy. Soc., Series A, 1902, Vol. 199, page 55.

[3] *Loc. cit.*

[4] "World Power," 1925, Vol. iii., page 302.

[5] "Power," 1925, Vol. 62, page 134.

[6] *Journal* Roy. Soc. of Arts, 1926, Vol. lxxv., pages 245 *et seq.*

[7] "Phil. Trans." Roy. Soc., Series A, 1902, Vol. 199, page 55; and 1912, Vol. 212, page 1.

[8] Those for Fahrenheit degrees are reproduced on the opposite page as Tables I., II., and III.—ED. THE E.

SIXTY YEARS AGO.

THE construction of street tramways within the Metropolitan area provided a recurrent topic for discussion throughout the 'sixties of last century. Up to 1869 the experience derived from such short lengths of more or less experimental street tramways as had been laid in this country was, on the whole, distinctly unfavourable to them. According to two articles on the subject which appeared in our issues of April 23rd and April 30th, 1869, a tramway had been worked successfully in the neighbourhood of Preston from 1827 to 1839, and had proved neither a danger nor an inconvenience to the stage coaches which had to cross it. In the early 'fifties tramways had been laid in New York and other American cities and in Paris. In 1857 the London General Omnibus Company proposed to construct tramways from Notting Hill Gate to Fleet-street and the Bank with numerous branches, but permission to carry out the work was presumably denied it. Then in 1860 Mr. G. F. Train, an American, laid down a tramway of the New York pattern at Birkenhead and in 1861 in London. He had failed to obtain parliamentary sanction for his schemes, and carried them through by authority of the local bodies responsible for the roads. In both cases Train's tramways were indicted as a nuisance, and had to be removed, the chief ground of objection being the danger which their stepped rails caused to other traffic on the roads. In the years 1862, 1865, 1866, 1867 and 1868 various public and private bills for the construction of tramways in different parts of this country were promoted in Parliament, but all were unsuccessful except one in 1868 for a tramway in Liverpool. In 1869 three tramway Bills for the Metropolitan area were introduced, and although a vigorous attempt was made to stifle them before their merits had been discussed in Committee, all three passed their second reading, and were sent for examination by a Committee. These three Bills, the Metropolitan Street, the Pimlico, Peckham and Greenwich Street and the Metropolitan Tramway Bills, were supported by the vestries and local boards of works, by the Board of Trade, and by the public generally. It was widely felt that the unfortunate experiences with Train's rails should be forgotten, and that street tramways should be given a fresh trial. In spite of the opposition of the London General Omnibus Company, now an opponent of the construction of tramways, the Bills were approved by the Committee and Parliament was recommended to grant the promoters power to construct certain trial portions of their projected lines. The tide had turned largely because of the improvements made in the form of rail section whereby the danger to other forms of street traffic was lessened. Between 1869 and 1871 Acts were passed for the construction of 61 miles of street tramways in London, and in the closely succeeding years similar Acts were passed authorising the construction of tramways in Glasgow, Edinburgh, Dublin and other centres.

PROPERTIES OF SATURATED AND SUPERHEATED STEAM

TABLE I.—*Properties of Saturated Steam in Foot-pound Fahrenheit Units on a Temperature Basis.*

Temp. ° F.	Pressure, lb./sq. in.	Volume, cu. ft./lb.	Entropy, B.Th.U. per lb., per ° F.		Total and latent heat, B.Th.U. per lb.			Temp. ° F.	Pressure, lb./sq. in.	Volume, cu. ft./lb.	Entropy, B.Th.U. per lb. per ° F.		Total and latent heat, B.Th.U. per lb.		
t	p	V	$\varphi\omega$	φs	h	L	H	t	p	V	$\varphi\omega$	φs	h	L	H
400	249·4	1·8572	0·5617	1·5338	375·1	831·3	1206·4	590	1431·9	0·3029	0·8029	1·3556	605·4	580·1	1185·5
410	279·2	1·6622	0·5794	1·5244	386·0	822·0	1208·0								
420	311·6	1·4939	0·5917	1·5150	397·0	812·2	1209·2	600	1542	0·2764	0·8161	1·3446	619·7	560·0	1179·7
430	346·9	1·3459	0·6043	1·5058	408·2	802·2	1210·4	610	1658	0·2518	0·8296	1·3330	634·7	538·3	1173·0
440	385·1	1·2150	0·6167	1·4967	419·6	791·6	1211·2	620	1781	0·2282	0·8433	1·3207	649·8	515·5	1165·3
								630	1911	0·2073	0·8573	1·3076	665·8	490·6	1156·3
450	426·5	1·0989	0·6289	1·4876	430·8	781·0	1211·8	640	2049	0·1869	0·8719	1·2937	682·5	463·5	1146·0
460	471·1	0·9950	0·6412	1·4786	442·1	770·0	1212·1								
470	519·2	0·9033	0·6536	1·4697	453·6	758·8	1212·4	650	2195	0·1676	0·8876	1·2785	700·8	433·3	1134·1
480	571·0	0·8209	0·6658	1·4607	465·2	747·1	1212·3	660	2351	0·1490	0·9041	1·2618	719·9	400·2	1120·1
490	626·5	0·7471	0·6780	1·4517	476·9	734·9	1211·8	670	2516	0·1307	0·9216	1·2431	740·6	362·7	1103·3
								680	2693	0·1124	0·9424	1·2216	764·9	317·7	1082·6
500	686·1	0·6807	0·6901	1·4428	488·9	722·2	1211·1	690	2886	0·0936	0·9676	1·1958	793·9	262·9	1056·8
510	749·7	0·6211	0·7024	1·4337	500·9	709·2	1210·1								
520	817·7	0·5669	0·7148	1·4246	513·4	695·2	1208·6	700	3099	0·0731	1·0034	1·1629	833·5	188·7	1022·2
530	890·2	0·5182	0·7271	1·4154	525·7	681·1	1206·8	705·2	3222	0·0607	1·0285	1·1404	867·2	130·4	997·6
540	967·5	0·4739	0·7395	1·4060	538·3	666·3	1204·6	707	3268	0·0560	1·0407	1·1311	882·0	105·4	987·4
								710	3350	0·0539	—	—	883·2	84·3	967·5
550	1049·6	0·4336	0·7519	1·3965	550·9	651·1	1202·0	716	3563	0·0453	—	—	872·5	20·7	893·2
560	1136·8	0·3966	0·7644	1·3867	564·2	634·6	1198·8								
570	1229·4	0·3626	0·7769	1·3767	577·6	617·3	1194·9	717	3650	0·0413	1·0086	1·0086	846	0	846
580	1327·5	0·3317	0·7899	1·3664	591·3	599·3	1190·6								

TABLE II.—*Properties of Saturated Steam in Foot-pound Fahrenheit Units on a Pressure Basis.*

Press., lb./sq. in.	Temp., ° F.	Volume, cu. ft./lb.	Entropy, B.Th.U. per lb. per ° F.		Total and latent heat, B.Th.U. per lb.			Press., lb./sq. in.	Temp., ° F.	Volume, cu. ft./lb.	Entropy, B.Th.U. per lb. per ° F.		Total and latent heat, B.Th.U. per lb.		
p	t	V	$\varphi\omega$	φs	h	L	H	p	t	V	$\varphi\omega$	φs	h	L	H
400	443·8	1·1712	0·6212	1·4933	423·7	788·1	1211·8	1200	566·9	0·3727	0·7734	1·3798	573·4	622·7	1196·1
450	455·4	1·0419	0·6357	1·4827	437·0	775·1	1212·1	1400	587·1	0·3111	0·7992	1·3587	601·3	585·6	1186·9
500	466·1	0·9380	0·6487	1·4732	449·1	763·2	1212·3	1600	605·1	0·2635	0·8230	1·3386	627·3	548·7	1176·0
600	485·4	0·7805	0·6722	1·4559	471·6	740·4	1212·0	1800	621·5	0·2255	0·8454	1·3186	652·4	511·4	1163·8
700	502·1	0·6672	0·6929	1·4407	491·6	719·5	1211·1	2000	636·5	0·1936	0·8669	1·2985	676·8	473·0	1149·8
800	517·5	0·5804	0·7117	1·4269	510·1	699·0	1209·1	2400	663·1	0·1433	0·9098	1·2561	726·3	388·8	1115·1
900	531·3	0·5120	0·7288	1·4142	527·4	678·9	1206·3	2800	685·4	0·1029	0·9556	1·2078	780·4	290·6	1071·0
1000	544·1	0·4570	0·7443	1·4021	543·6	659·8	1203·4	3200	704·4	0·0645	1·0231	1·1463	861·7	144·5	1006·2

TABLE III.—*Properties of Superheated Steam in Foot-pound Fahrenheit Units at Pressures from 400 lb. to 4000 lb.*
Temperature t on the Fahrenheit scale. Total heat H in B.Th.U. per pound. Volume V in cubic feet per pound. Entropy φ in B.Th.U. per pound per deg. Fah.
NOTE.—The first line under each pressure gives the values of H, V and φ for dry steam at the saturation temperature t_s.

P = 400 lb. per sq. in.				P = 450 lb. per sq. in.				P = 500 lb. per sq. in.				P = 600 lb. per sq. in.			
t	H	V	φ	t	H	V	φ	t	H	V	φ	t	H	V	φ
443·7	1211·8	1·1712	1·4933	455·4	1212·1	1·0419	1·4827	466·0	1212·3	0·9380	1·4732	485·4	1212·0	0·7805	1·4559
450	1216·0	1·1841	1·4983	500	1243·7	1·1296	1·5166	500	1237·4	1·0007	1·4998	500	1223·9	0·8055	1·4684
500	1249·8	1·2898	1·5345	550	1276·1	1·2192	1·5495	550	1271·2	1·0847	1·5341	550	1260·8	0·8822	1·5059
550	1281·0	1·3870	1·5664	600	1306·5	1·3033	1·5789	600	1302·4	1·1627	1·5643	600	1294·1	0·9513	1·5381
600	1310·4	1·4788	1·5947	650	1335·4	1·3836	1·6056	650	1332·1	1·2365	1·5916	650	1325·2	1·0159	1·5667
650	1338·8	1·5670	1·6209	700	1363·4	1·4609	1·6302	700	1360·5	1·3076	1·6167	700	1354·7	1·0773	1·5928
700	1366·3	1·6528	1·6451	750	1390·6	1·5361	1·6532	750	1388·1	1·3762	1·6400	750	1383·2	1·1362	1·6168
750	1393·0	1·7364	1·6677	800	1417·2	1·6100	1·6748	800	1415·1	1·4435	1·6619	800	1410·8	1·1937	1·6392
800	1419·4	1·8182	1·6890	850	1443·4	1·6825	1·6951	850	1441·5	1·5092	1·6824	850	1437·8	1·2498	1·6602

P = 700 lb. per sq. in.				P = 800 lb. per sq. in.				P = 900 lb. per sq. in.				P = 1000 lb. per sq. in.			
502·1	1211·1	0·6672	1·4407	517·5	1209·1	0·5804	1·4269	531·3	1206·3	0·5120	1·4142	544·1	1203·4	0·4570	1·4021
550	1249·8	0·7361	1·4802	550	1237·7	0·6251	1·4558	550	1224·5	0·5371	1·4321	550	1209·9	0·4649	1·4084
600	1285·4	0·7997	1·5147	600	1276·3	0·6851	1·4931	600	1266·5	0·5953	1·4728	600	1256·1	0·5226	1·4532
650	1318·1	0·8578	1·5448	650	1310·8	0·7389	1·5249	650	1303·1	0·6459	1·5065	650	1295·1	0·5712	1·4892
700	1348·8	0·9126	1·5719	700	1342·7	0·7887	1·5531	700	1336·5	0·6921	1·5359	700	1330·0	0·6148	1·5200
750	1378·1	0·9647	1·5966	750	1373·0	0·8358	1·5786	750	1367·7	0·7354	1·5623	750	1362·4	0·6551	1·5473
800	1406·4	1·0149	1·6196	800	1402·0	0·8811	1·6022	800	1397·6	0·7767	1·5865	800	1393·0	0·6933	1·5721
850	1434·0	1·0640	1·6410	850	1430·2	0·9249	1·6240	850	1426·3	0·8165	1·6089	850	1422·4	0·7299	1·5950
900	1461·0	1·1121	1·6611	900	1457·6	0·9677	1·6446	900	1454·2	0·8552	1·6298	900	1450·8	0·7653	1·6163

P = 1200 lb. per sq. in.				P = 1400 lb. per sq. in.				P = 1600 lb. per sq. in.				P = 1800 lb. per sq. in.			
566·9	1196·1	0·3727	1·3798	587·1	1186·9	0·3111	1·3587	605·1	1176·0	0·2635	1·3386	621·5	1163·8	0·2255	1·3186
600	1232·7	0·4108	1·4148	600	1204·2	0·3264	1·3751	650	1235·6	0·3099	1·3933	650	1208·6	0·2565	1·3595
650	1277·9	0·4578	1·4565	650	1258·3	0·3746	1·4251	700	1285·6	0·3488	1·4374	700	1267·4	0·2972	1·4114
700	1316·5	0·4980	1·4909	700	1301·8	0·4133	1·4635	750	1327·1	0·3812	1·4724	750	1313·6	0·3292	1·4520
750	1351·3	0·5341	1·5201	750	1339·6	0·4470	1·4954	800	1364·0	0·4099	1·5023	800	1353·3	0·3567	1·4826
800	1383·8	0·5678	1·5463	800	1374·1	0·4777	1·5233	850	1397·9	0·4363	1·5287	850	1389·1	0·3815	1·5105
850	1414·5	0·5997	1·5702	850	1406·3	0·5063	1·5484	900	1429·8	0·4611	1·5525	900	1422·4	0·4046	1·5354
900	1444·0	0·6304	1·5923	900	1436·9	0·5336	1·5713	950	1460·0	0·4847	1·5745	950	1453·6	0·4262	1·5581
950	1472·3	0·6598	1·6129	950	1466·2	0·5597	1·5925	1000	1489·4	0·5076	1·5949	1000	1483·8	0·4471	1·5791

P = 2000 lb. per sq. in.				P = 2400 lb. per sq. in.				P = 2800 lb. per sq. in.				P = 3200 lb. per sq. in.			
636·5	1149·8	0·1936	1·2985	663·1	1115·1	0·1433	1·2561	685·4	1071·0	0·1029	1·2078	703·5	1006·2	0·0645	1·1463
650	1175·4	0·2099	1·3218	700	1193·8	0·1842	1·3253	700	1114·9	0·1224	1·2476	750	1158·7	0·1240	1·2769
700	1246·6	0·2543	1·3847	750	1263·9	0·2206	1·3849	750	1219·9	0·1691	1·3363	800	1250·4	0·1597	1·3510
750	1298·8	0·2869	1·4288	800	1316·8	0·2480	1·4274	800	1287·0	0·1991	1·3906	850	1312·8	0·1840	1·3997
800	1342·0	0·3137	1·4638	850	1360·3	0·2706	1·4613	850	1338·1	0·2218	1·4305	900	1362·2	0·2032	1·4366
850	1380·0	0·3374	1·4934	900	1398·8	0·2906	1·4900	900	1381·4	0·2411	1·4628	950	1404·0	0·2195	1·4670
900	1415·0	0·3592	1·5194	950	1433·7	0·3087	1·5154	950	1419·3	0·2580	1·4904	1000	1441·9	0·2343	1·4933
950	1447·1	0·3793	1·5429	1000	1466·7	0·3259	1·5383	1000	1454·6	0·2737	1·5149				
1000	1478·4	0·3988	1·5645												

P = 3600 lb. per sq. in.				P = 3600 lb. per sq. in.				P = 4000 lb. per sq. in.				P = 4000 lb. per sq. in.			
750	1067·1	0·0785	1·1953	900	1340·6	0·1729	1·4125	800	1140·7	0·0931	1·2487	900	1316·1	0·1477	1·3850
800	1203·5	0·1254	1·3054	950	1387·3	0·1890	1·4445	850	1246·4	0·1260	1·3316	950	1369·0	0·1642	1·4223
850	1282·8	0·1528	1·3673	1000	1428·3	0·2033	1·4730					1000	1413·8	0·1782	1·4535

Oil, Coal and Iron Enterprises in South Manchuria.

By W. F. COLLINS, A.R.S.M., M.I.M.M.*

FOREIGN guidance and a measure of control were imposed upon China as a result of the Boxer excesses in 1900. Efforts, mainly diplomatic, have been made by the Chinese with increasing frequency and some success to shake off this foreign influence. In South Manchuria, however, the foreign guidance has been accompanied by Japanese industrial development on a large scale, involving the investment of considerable sums of money and the dawn of vast commercial prosperity. Japan's industrial development in South Manchuria is, therefore, rapidly becoming a matter of first importance in Far Eastern economics as well as in politics. Neutralisation of foreign influence in this area has become a problem in which boycott and the "talkee-talkee" of the politician are alike of little avail. Every foreigner in North China has long been asking, "Will Japan, now bearing the full brunt of Chinese exclusiveness in its modern form, consent without a struggle to give up the rights and properties for which she defeated the Russians in glorious war in 1904, and on which she has spent many tens of millions sterling since that date, or will she again be ready to protect by force of arms rights which have been granted to her by due legal process?" These rights, if capitalised under the expectation, very possibly good, of the prolongation of the peaceful conditions now existing in Manchuria would now run into values exceeding the 200 million sterling mark. The answer to these questions is in the lap of international politics. Chang Tso-lin, long the strong hand in Manchuria, is dead, and his son, known as the Young Marshal, weak and inexperienced, has succeeded to the satrapy. He favours industrial and agricultural development of the province. His father was successful in securing construction of some hundreds of miles of railway since the Great War, mainly with Chinese capital. These railways are lamentably equipped and enjoy very little credit. In other respects, except for the settling of vast areas with the yearly million of colonists from other parts of China, who are flowing into Manchuria, practically nothing has been done. The Young Marshal also states that he is anxious to expand industrial enterprises with foreign capital, but no Chinese official since Manchu times has had the combination of brains and power necessary to attract foreign industrial capital to the country. The Chinese idea of attracting foreign capital is to ask that 50 per cent. of the profits, and no losses, should accrue to China, the foreigner putting up all the capital and enjoying neither the right of residence in the land of Sun Yat-sen, nor ownership of property in that flowery but inhospitable corner of the globe. Capital, in consequence, goes and will continue to go elsewhere. And what of Japan? Unfortunately for the aspirations of Young China, the Japanese were able to secure their present concessions in Manchuria on sound terms imposed at the point of the bayonet in 1904 and in 1917.

The South Manchurian Railway itself is the heart and nervous system, controlling the whole future of industrial development in the Chinese area east of the Great Wall and South of Mukden. For the construction of this railway, 700 miles in length, 14 millions sterling of British money, were raised in 1906 onwards. Its total capital is 40 millions sterling-equivalent, owned, as to half, by the Japanese Government. Further sums amounting to approximately 12 millions sterling have been raised in Japan to build its subsidiary railways. The line itself is well quipped and managed with remarkable efficiency. Rolling stock is abundant. Trains leave without delay and passengers travel in a comfort and safety totally unknown in China proper. The railway has its own locomotive and car factory at Sakaku, near Dairen, with an annual output capacity of forty locomotives and 650 freight cars. Were the China's railways ready to pay for rolling stock, in any measure commensurate with their needs, these works, with the company's own cheap supplies of coal, steel and labour, would be capable of expansion, and within a few years could tender successfully in many parts of China.

Other main subsidiary industrial enterprises of the railway are the harbour of Dairen, which in twenty-four years has been developed into a port second only in importance to Shanghai; the Anshan ironworks; the Fushun coal mine, now the most important open-cast colliery in the world; and, finally, the Fushun shale oil deposit and extraction plant. This plant—see Figs. 1 and 2—whose construction will cost about a million sterling, is being built as a result of exhaustive experiments over a term of years. It is the last word of the metallurgist in the problem of scientific treatment of oil shale, a matter of extreme economic importance in many countries.

FIG. 1—THE FUSHUN SHALE OIL EXTRACTION WORKS

The Fushun Colliery near the capital city of Mukden has been developed from an output of one ton per day when taken over in 1909, to 6000 tons per day in 1916, 20,000 in 1924, and 25,000 to 30,000 tons at the present time. This coal is produced at a cost of approximately 3s. per ton, and is rapidly placing this semi-official Japanese enterprise in a position of being able to undersell all colliery opposition in North China and to make or mar the fortunes of any industrial enterprise in South Manchuria depending on fuel for its existence. The mine is equipped with a 16,000-ton capacity washing plant, coke ovens, electric power station, sulphuric acid, chlorate, sulphate and other by-product plants which are gradually being developed to importance corresponding to that of the mine itself. The most recent enterprise consists in the exploitation of the 400ft. thick stratum of oil shale, which has to be stripped in the working of the coal. Experiments in progress since 1923 have led to the installation of eighty Hardman type retorts, having a daily capacity of 50 tons each of shale. This plant, which will start operation in October of this year, will produce 50,000 tons of crude oil, destined for the Japanese Navy, and 10,000 tons of paraffin annually. Refining will take place at the Navy Fuel Depôt, at Tokuyama, in Japan.

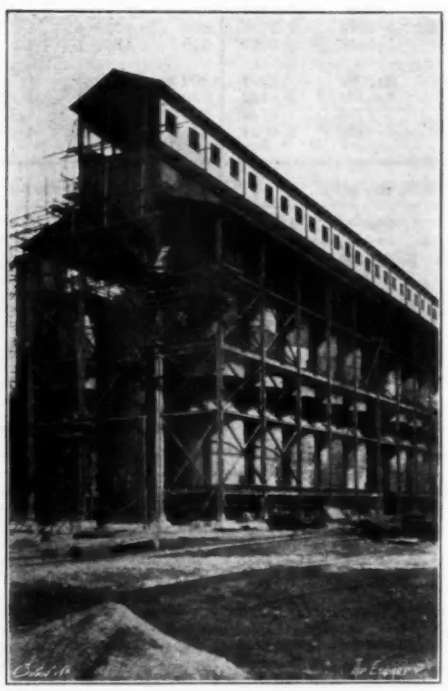


FIG. 2—THE FUSHUN SHALE OIL WORKS

The Anshan ironworks is a small plant with two 300-ton blast-furnaces, erected during the war to treat a low-grade ore after roasting, magnetic separation and sintering. The addition of a 500-ton blast-furnace and a steel works to deal with an annual production of 400,000 tons of pig and costing about 5 millions sterling, will be completed in 1931.

There is also in operation a cement plant near Dairen. A soda ash factory, having an initial capacity of 50,000 tons, approximately half of the present importation into Japan, is now projected, and is likely to be completed by the end of 1930. At Anshan there is also in course of erection at a cost of about 1½ millions sterling, a nitrogen plant, which will utilise the waste blast-furnace gases as fuel.

The S.M.R. endeavoured in March to raise a loan of 35 million yen at 5½ per cent. by issue of bonds in Japan. The Japanese public, however, has left four-fifths of the issue on the hands of the underwriters. In the case of the soda ash factory, a company having a capital of approximately half a million sterling is being organised, and a guarantee will be given by the S.M. Railway Company to the shareholders that they shall secure a minimum profit of 5 to 5½ per cent. during the first ten years of operation.

Mr. Matsuoka, vice-president of the S.M.R., stated in March that the co-operation of foreigners is cordially invited for the development of the railway's numerous enterprises. These enterprises are situated in China, and meet with but little goodwill from the Chinese. It will be readily understood that in the absence of Japanese armed force any Chinese Tuchun would wreck this railway and its subsidiary enterprises with a readiness excelling that with which he has despoiled the railways and mines of China proper. Consequently, future prosperity or disaster depends entirely upon the question as to whether Japan will, if necessary, give armed protection in case China, by means of tariffs or the other numerous manipulations of labour legislation, boycott or confiscation currently practised, takes active steps, as she has done in the case of at least one British enterprise, to ruin them. It is not surprising, therefore, that the present uncertainty is reflected in the timidity of Japanese capital in lending further financial support to semi-official enterprises abroad. This uncertainty should similarly tend to interfere with the offer of foreign capital for industrial development, except under very profitable inducements. It would seem that Japan has now to choose between two courses in the industrial development of South Manchuria, either to restrict development of these rapidly growing enterprises on account of their increasingly exacting need of vast capital sums, or to adopt a strong protective policy under which she will make it clear that her nationals who invest their money in South Manchurian industrial enterprises will not be subjected to the devious plunderings practised by Chinese officials on foreign as well as Chinese industry elsewhere in China.

In an endeavour to bark against the Japanese political and industrial thunderstorm which they see impending, the Chinese authorities at Mukden have stated that they, too, are anxious to encourage foreign industrial enterprise in South Manchuria. There seems little probability, however, that the Chinese themselves will succeed in interesting foreign capital in industrial enterprises there or anywhere else outside the foreign concessions. The foreign industrialist has been too many times bitten. The Chinese, as a nation, have but little capacity for building up industrial enterprises, and, as has been pointed out already, the South Manchurian Railway, possessing an almost inexhaustible supply of phenomenally cheap coal, is in a position to ruin any enterprise depending on coal, which may set itself to compete with any of its numerous subsidiary activities.

* Author of "Mineral Enterprise in China."

Mexborough Water Supply—Water Softening Installation.

THE water supply of Mexborough is derived from two sources: first from borings sunk in the Millstone Grit, and secondly from what are known as the Ludwell Springs. The supply was begun in 1879 by the Mexborough and District Water Company, and at that time, and for many years thereafter, boreholes in the Millstone Grit were the only sources of supply. The undertaking of the water company was purchased by the Urban District Council by arbitration in 1917, and though certain additions were made to the boreholes and pumping plant, it was not until March, 1927, that the Council acquired the Ludwell Springs and thus became possessed of a second source of supply.

Now, the water obtained from both sources is of exceedingly high organic purity, but it is undeniably hard. The supply from the borings has a total hardness of no less than 44·7 deg., English, in the proportion of 15·05 deg. temporary, to 29·68, permanent, hardness. That is the type of water to which the consumers had been accustomed for the last fifty years or so. It is interesting to note, in passing, that in 1915 the death-rate in the area covered by the supply was only 13 per 1000—a low figure, which does not seem to indicate that the water, hard as it was, was particularly harmful to those who drank it.

When, in 1927, the Ludwell Springs were acquired, water of a substantially different character—chemically—was added to the supply. The output of these springs has the characteristics of water obtained from the magnesian limestone. It has a total hardness varying between 31·9 deg. and 34·66 deg., English, the temporary hardness averaging 20·65 deg.—as compared with the 15·05 deg.

of the borings water—and the permanent hardness averaging 14·01 deg.—as compared with 29·68 deg.

For half a century or thereabouts, hard water has, as we have said, been supplied to consumers without being treated in any way, in spite of the manifest disadvantages attaching to such a high percentage of calcium and magnesium compounds. Possibly the fact that it was manifestly not harmful to health may explain to some extent why the water was subjected to no treatment saving filtration. Within the past couple of years, however, the Urban District Council appears to have awakened to the facts that :—" The water, when boiled in kettles or other vessels, deposits mineral matter, which forms a dense incrusting layer in such vessels. It also consumes an undue quantity of soap in washing, and the effect of drinking the water, on certain subjects, is held by some authorities to predispose to digestive and other troubles." The foregoing is a quotation from a brochure prepared by the Council for distribution at the opening ceremony of a treatment plant which has recently been put into operation. " The aim of the Council," we read further, " has been to remove this drawback and to render the Public Water Supply of Mexborough second to none in Great Britain, not only as regards organic purity, but also in respect of its suitability for general domestic use, and, what is almost as important, its applicability for industrial purposes."

The town, the brochure goes on to explain, is served by two railway systems, and has an excellent and cheap electricity supply, possesses many ideal sites for the establishment of works of various kinds, and " it is anticipated that the removal of the disadvantages attending a hard water supply will attract industrial concerns to the locality."

The cynic might almost be forgiven for observating that not until the industrial advantages of soft water were manifest, was the injurious effects of hard water upon the health of the inhabitants discovered. But in that respect Mexborough differs little from many other places which owe sanitary developments to the requirements of industries.

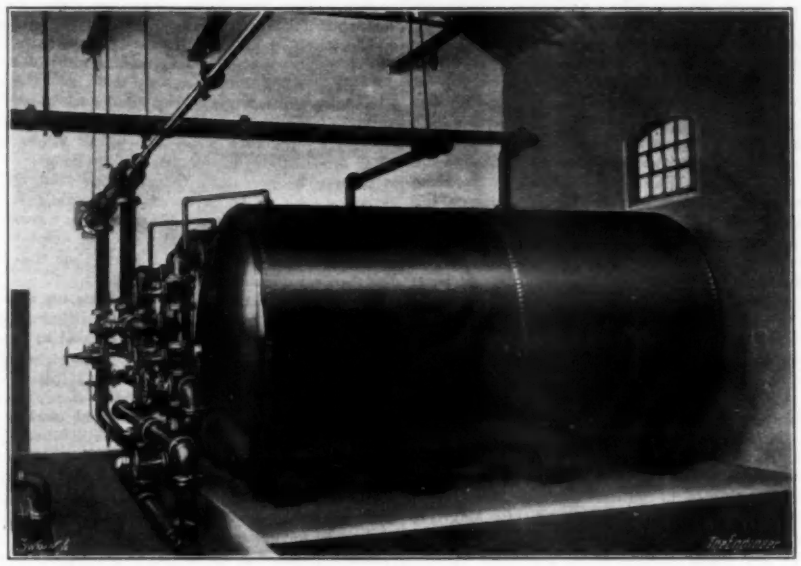
In any case, it was decided to soften the water, and Mr. J. Barnet Feltham, the Council's water engineer and manager, was instructed to go into the matter. After careful investigations of all existing methods of softening public water supplies Mr. Feltham advised the adoption of the " Permutit " base exchange system, and his recommendation was adopted. The work of installing the necessary plant to his specification and under his superintendence was entrusted to United Water Softeners, Ltd.

The plant put in is designed for a capacity of 20,000 gallons per hour, and it is arranged to operate in six-hour cycles between regenerations of the " Permutit," thus providing a total quantity of 120,000 gallons of softened water between each regeneration. It comprises—see the accompanying engravings—two units, consisting of riveted steel cylinders 8ft. 6in. in diameter by 15ft. long, constructed to withstand a working pressure of 125 lb. to the square inch, and arranged horizontally. The two units together contain, approximately 50 tons of " Permutit," which forms a bed about 3ft. 6in. deep in each shell, the bed being supported on a layer of Silex material, which, in turn, rests on a concrete foundation at the bottom of the cylinder. Embedded in the Silex is the collecting system, which consists of a cast iron main-header pipe, provided on each side with a series of lateral branches, the latter being constructed of wrought iron and fitted with sockets, in each of which is screwed a strainer of special design. The disposition of the lateral pipes and strainers has been arranged with a view to ensure entirely even collection of the water throughout the whole of the bed of softening material, and to avoid channelling or short-circuiting of the water, as well as to secure the most intimate contact between the water and the softening material.

After its passage through the " Permutit " bed the water is drawn off into the main-header through the strainers and lateral pipes, and is delivered into a main which discharges into a reservoir.

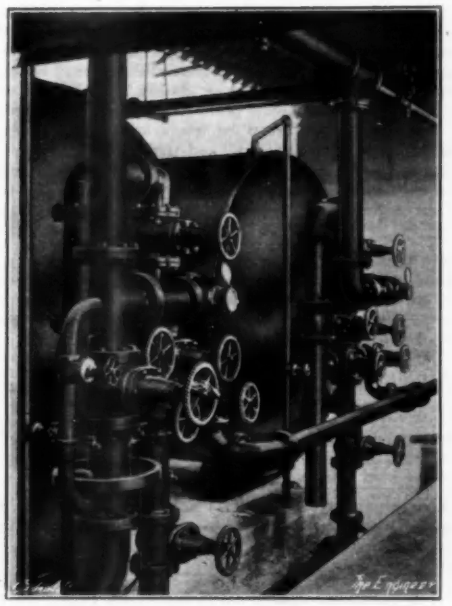
As the " Permutit " process removes all the lime and magnesia from the water, and as it was decided that the water, as supplied, should have 10 deg. of hardness, arrangements were made by which certain quantities of the two waters—borehole and spring—in the proportions of one of the former to two of the latter, should be completely softened, afterwards blending this treated water with the necessary volume of hard water to give the whole a resultant hardness of 10 deg.

The salt for the regeneration is stored in concrete tanks measuring 9ft. 6in. by 11ft. by 5ft. 6in. deep, which can contain some 29 tons of salt, the material being delivered into them direct from wagons. A water supply is so arranged that a saturated solution of brine is constantly maintained in these tanks, which are connected to the softening tanks. The regeneration is effected on the two-stage principle. The saturated brine is allowed to flow into a dilution tank in which it is thoroughly mingled with diluting water by means of a water injector and brought to the desired strength. It is then drawn from the tank by motor-driven pumps, and discharged into the " Permutit " units, being evenly distributed over the bed of softening material. In ordinary service, one unit is in operation while the other unit is being regenerated. The time taken for regeneration is approximately from thirty-five to forty minutes.



"PERMUTIT" SOFTENING PLANT AT MEXBOROUGH WATERWORKS

It is interesting to note that though the " Permutit " system is extensively used in large institutions, hotels and private houses, Mexborough is only the second town in the United Kingdom to apply it for the purposes of a public supply, the other installation being that of the West Cheshire Water Board at Hooton in Cheshire.



CONTROL VALVES OF "PERMUTIT" CYLINDERS

A RECENT investigation on " The Determination of Tantalum and Columbium," conducted at the Rare and Precious Metals Experiment Station of the United States Bureau of Mines, Department of Commerce, in co-operation with the University of Nevada, at Reno, Nevada, makes use of an entirely new method for the separation of these two elements. It possesses an advantage both in time and expense over the older methods of obtaining columbium free from tantalum. Should this method prove satisfactory for the separation of large quantities of these elements, it should result not only in a cheaper production of tantalum but in the stimulation of interest in columbium and should bring into use one more of the rarer metals, the properties of which have been so beneficial to the manufacturing industries.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

CONTRACTORS' WORK IN SPAIN.

SIR,—The opportunity of selling material to contractors in Spain has been neglected in an astonishing way. Only a few of the leading British firms have temporary or permanent representatives. In one case, one man is agent for some twenty odd leading firms, all British, and naturally even the most intelligent and pushing business man cannot do his duty to such a large variety of lines. With the coming of the Directorate, an enormous construction programme is being carried out, including ports, roads, railways and hydro-electric schemes.

It may be of interest to consider some of the procedure in use in this country. A large construction company will study a project and submit it to the Government, which may or may not approve of it. Should it do so, it gives out the job to public tender. At the same time it publishes an estimate of what the work is likely to cost. The tendering firms lodge their offers, stating at what percentage *below* the Government price they will undertake the contract. Whatever tender is accepted, the lowest or any other, the original contracting company who made the project has the right to claim it at that price. This is called the right of *tanteo*. Generally, the company will then subcontract it, often to the bidders for the tender, deducting a percentage for their own use and for the supervision of the work for which they are responsible to the Government. A large number of firms generally tender, and as a result, the rates have been declining considerably. Still, for anybody who knows the methods of working in use and the comparative low cost of labour, there is a profit to be made, especially by a firm that would not hesitate to equip itself in a modern way.

Owing to the short time of development, the new programme of construction came to the country like a bombshell, and the present type of contractor, with few exceptions, is of a very poor class. Most of them attempt all they can to adapt the ancient ways of working to modern jobs, and modern time limits. Practically none of them have had experience outside Spain, and any new method is looked at with distrust. For the same reason, the amount of construction labour is very limited, and what there is rules the roost. In the tunnels and trenches miners are mostly used, and they are attempting to preserve the antiquated methods in use in their mines. In many cases the contractors have not the slightest idea of the work, and are completely in the hands of their men. Incredible as it may seem, I know of one case where the miners work four hours but are paid for ten. In very few places have the contractors the energy to force their labour to use modern plant and methods.

For this reason, the leading pneumatic tool companies have each a staff which is purely advisory and visits the work, directing and helping and trying to solve the contractors' problems. But it is an uphill fight ; not only the contractor but also the workman has to be convinced.

The line Zamorra–Orense, Orense–Santiago is partly under construction. The piece in the middle, which has not been handed over to the main construction company, has now been given out, and is being sub-let. The line will reach a maximum elevation of 1142 m. above sea level. The part from Sanabria to Orense is 143 kiloms. long and will have seventy-six tunnels of a combined length of 43 kiloms., of which the Padernelo tunnel alone will be 5½ kiloms. long. Nine tunnels will be over 1 kilom. long each. The Orense–Santiago line will have a maximum elevation of 428 m., and seventy-two tunnels, with a combined length of 66 kiloms. The watershed tunnel at Fojo del Cabrito will be 2632 m. long. This line will have a total length of 136 kiloms. One of the viaducts over the river Ulla will be 78 m. high, and have a main arch of 66 m.

This will give an idea of the importance of some of the work which is being carried on in Spain. It is only a small part of it.

If the reader imagines that the designs are behind the times, he is mistaken. The Spanish engineer is an excellent designer, and hardworking and conscientious. It is only in the organisation and execution that he fails, mostly owing to lack of experience. Quite a number of concrete bridges are under construction using suspended falsework, thus being independent of the rise and fall of the rivers and the traffic on the same.

The greatest faults are to be found in the construction of tunnels and the excavation of trenches. Tunnels are being built with flying arches. The usual method is to run a top pioneer drift and widen this out ; dig two trenches at the side to springing line, and place concrete arches. To remove the toe the arches are not underpinned, but natural walls are left standing and removed as the concreting or building up of the side walls proceeds. As a result, there have been a few cases of arches cracking before the walls were up to the spring line, and naturally the method does not allow for the free use of shovels in the tunnels, as the side walls restrict the available space. There is not a single one used in any of the present tunnels, but a number of British, American and German shovels are employed on station sites and in trenches. None of the contractors was aware at the start what machinery would be required, and all are understocked in compressors and air supplies, and have to make good when a large part of the construction time is past. The only mechanical means in use are pneumatic drills, a few tugger hoists, and some German petrol locomotives. The tip wagons are of local or German manufacture and of poor design. Ventila-

tion is practically completely neglected, and only lately a "go-ahead" Government engineer has insisted on wet drilling in pioneer drifts. But odd to say, the men object to this improvement, which is only to their own benefit, and do all that is possible to lose or destroy the parts required for the process.

Electric firing is unknown and the only cartridges available are of the 1in. size, so that when using large pneumatic drills the full benefit of having the charge at the bottom of the hole is nullified.

Concrete is mostly mixed by hand, and in the tunnels broken rock from the pioneer drift and sifted rock dust are used for lining.

There are no provisions for housing labour, and medical supplies are left to the goodwill of the contractor, but nearly all the villages have a doctor and are within a few hours' reach from the work.

The labourer lives or herds in local farmhouses, villages, &c., sometimes many miles away from the work. The local labour, being generally of the farming class, cannot be relied on in harvest or sowing time. The men are mostly willing and hardworking when looked after, but there is a great lack of intelligent and trained foremen.

As a result, the number of accidents is very large. Incredible carelessness adds to them. In one case frozen dynamite was being thawed on the exhaust pipe of a portable air compressor. In another case, the foreman drilled into a partly loaded hole, as it "was not deep enough." Dynamite is lying all over the tunnels, and owing to the primitive loading process—tamping is done with a piece of paper only—quite a lot of power is shot undetonated into the muck-piles. The lighting is done universally with carbide lamps of a very cheap kind. These have no reflectors, and have to be lit with matches. The American kind, with a stone and flint wheel, like a cigarette lighter, is preferable.

As regards trade with the contractors, the usual terms are six months' credit for small supplies and payment of 15 per cent. on delivery, and the balance within a year for large material. Payments are generally safe, as nearly all the contractors work with reputable banks.

Hoping that this will interest you.

W. J. BRANDS.

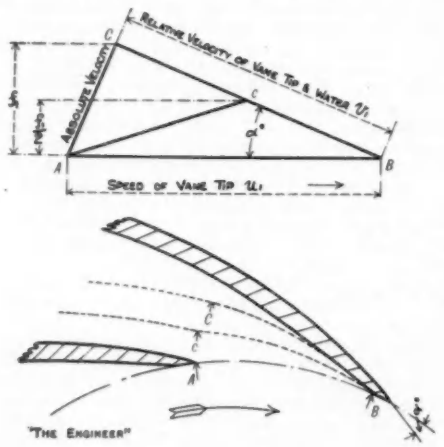
La Coruña, April 23rd.

HOW DO CENTRIFUGAL PUMPS ACT?

SIR,—Having read most of the English and American literature on centrifugal pumps, I feel that no apology is needed for putting the above question, and should be glad if someone would comment on the following, in the hope that some additional light may be shed on the subject.

Considering the conditions existing at the entrance to the impeller channels, first, when the normal quantity is passing—*i.e.*, the quantity at which the efficiency is a maximum for a given speed of revolution—and, secondly, when some other quantity is passing, for example, 50 per cent. of the normal discharge. If the first set of conditions is represented by the inlet diagram A C B in Fig. 1, what form of diagram might be expected from the second set?

I have failed to find an author, writing in English, who



FIGS. 1 AND 2

has dealt with the latter state, and inquiries made of various designers with whom I have been associated have indicated that the diagram A c B is generally accepted by them as representing the velocities at reduced quantity. I think, however, that the construction of the simple diagram in Fig. 2 will show this to be incorrect.

Referring to Fig. 2, if a particle of water P at the position B is moving with the absolute velocity given by A C in Fig. 1, it is possible, knowing the radial component f_1 and the time taken by the vane A to reach the point B, to plot the path of the particle from B to C. This dotted line B C then represents the outer boundary of the effective stream, *i.e.*, the stream conveying the normal quantity actually delivered by the pump, divided by the number of impeller channels, and including a small percentage to cover leakage. Similarly, the dotted line B c in Fig. 2 shows the upper limit of the effective stream when the pump is discharging half the normal quantity.

It is thus seen that the relative velocity v_1 at inlet is approximately constant for all quantities up to about the normal, or until the effective stream completely fills the channel area provided. From this point the value of v_1 will begin to increase.

This, I believe, is quite opposed to accepted theory. Otherwise, the statement would never have been made—as it has been by some authors—that for ordinary use the best form of inlet velocity diagram is an isosceles triangle.

G. URE-REID.

Newark-on-Trent, May 1st.

STEAM TURBINE DEVELOPMENT.

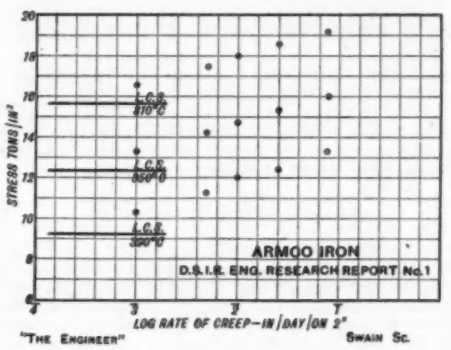
SIR,—Mr. Boulton's letter, published in THE ENGINEER of April 5th, directs attention to a matter of importance concerned with the use of metals in steam power plant operating at high temperatures, namely, the significance to be attached to the quantity that has become known as the "limiting creep stress." This quantity represents such a convenient idea, that it is not surprising the term has attained some degree of popularity. Nevertheless, in the interest of accuracy it is unfortunate that it ever was coined, as at the temperatures with which engineers are concerned, *i.e.*, 700 deg. Fah. and over, the existence of such a stress has yet to be demonstrated by experiment, and at low temperatures—*e.g.*, atmospheric temperature—continuous creep if it occurs at the rate that would be expected from its magnitudes at higher temperatures would, in any case, be altogether below any known means of measurement. Incidentally, a satisfactory analogy cannot be made with the phenomenon of fatigue.

So far the stresses that have been published by different investigators as limiting creep stresses are the result of an extrapolation of experimental data by a method that the writer considers to be insufficiently critical, not in accord with what might be expected from the properties of matter, and indeed misleading. On the other hand, by a different, and more searching method of plotting, limiting creep stresses are not only not obtained, but the experimental data gives no indication of the cessation of creep. The writer went into this matter at some length in a paper read on April 21st, 1927, before the North-Western Branch of the Institution of Mechanical Engineers, entitled "Physical Properties of Metals and Design of Plant for High-temperature Service." This paper was published in abstract in *Engineering* of July 8th, 1927, where examples employing data published by investigators who had determined limiting creep stresses were given to show that no such stresses were warranted by the experimental data when this was dealt with in a critical manner. As the question has been raised again, a further example may be offered to show that at present limiting creep stresses are not measured quantities, but the product of a particular form of extrapolation from experimental data, and for the present purpose it is most appropriate that we should use data from which limiting creep stresses have already been extrapolated.

The most complete published creep data upon any one material is that upon Armco iron, carried out at the National Physical Laboratory, and published by the Department of Scientific and Industrial Research, "Special Report No. 1 on Properties of Materials at High Temperatures." The following table gives values of the stress at different rates of creep for temperatures of 310 deg., 350 deg., and 390 deg. Cent., and the corresponding estimated limiting creep stresses. These values have been measured from Fig. 14 of the report.

Rate of extension, in./day on 2in.	Stress, tons per square inch. (Read from Fig. 14.)		
	310 deg. Cent.	350 deg. Cent.	390 deg. Cent.
0·075	19·15	16·0	13·24
0·025	18·56	15·24	12·39
0·01	17·96	14·78	12·0
0·005	17·48	14·19	11·22
0·001	16·6	13·24	10·27
Limiting creep stress	15·64	12·34	9·26

The accompanying figure shows the data of the table plotting with stress as ordinate and the logarithm of the



rate of extension as abscissae. Lines have been drawn to mark the limiting creep stresses.

Graphs have not been drawn to fit the plotted points, as their exact shape and tendency is a matter for individual judgment, but the writer feels that in no way can the data be considered to yield real limiting creep stresses, nor, as is indicated later, must this be taken to have been the intention. On the other hand, it does suggest that creep would continue to occur at lower stresses than those employed in the experiments. A significant fact is that the trend of the several curves is such that they would cut the limiting creep stresses determined by the investigators at about the same rate of creep, *i.e.*, corresponding to 4·4 on the figure, or approximately $10^{-5\cdot3}$ strain/hour, and from this it may be deduced that the limit of accuracy of experiments and method is of this order of magnitude. If such a rate of creep were less than any rate of practical consequence the limiting creep stresses obtained would, for all practical purposes, be as useful as real limiting values. This, however, is not the case. Such a rate operating for 200 hours or between eight and nine days, would extend a bolt holding a steam joint by an amount equal to its elastic strain, and thereby start leakage. In this particular application, the rate of creep would need to be not more than one hundredth of such a magnitude, *i.e.*, not more than 10^{-8} strain per hour. At present, no creep work with which the writer is acquainted has been carried to such a degree of refinement.

It may be necessary to point out that the qualified interpretation to be given to the limiting creep stresses dealt with by the report referred to is conveyed by the full information given of the method employed in their derivation and the statement made that the duration of the tests rarely exceeded seventy days.

As Mr. Boulton is anxious to have his ideas founded upon experimental evidence, attention has been confined to this aspect. A good deal can be said in favour of the view that if creep occurs under a given stress at one temperature, it may be expected to take place at a lower temperature. Sufficient has been done, however, to indicate that so far as experimental evidence goes, it suggests that creep is in all probability occurring under present common working conditions, and therefore no new phenomenon of the kind awaits the engineer who has the courage to make a reasonable advance to a higher working temperature, provided an appropriate reduction in working stress accompanies the advance.

Much useful, but academic, discussion can range around the subject of the validity of limiting creep stresses. As so far determined, the writer considers that such stresses refer to a particular rate of creep, *i.e.*, the rate which the apparatus or method is just incapable of detecting and consequently the results are directly comparable with stresses determined for a particular small rate of creep. It is not surprising, therefore, as may be inferred from data given by Mr. Guy in his paper, that although there is an unfortunate difference in the magnitudes of stresses determined by different investigators, a satisfactory agreement is reached for a given class of steels, *e.g.*, carbon steels when the stress at one temperature is expressed as a percentage of that at a given basis temperature, such as 750 deg. Fah., whether the stresses are given as limiting creep stresses or the stresses for a particular measured but small rate of creep. Consequently, there is really a very considerable body of concordant experimental data to guide engineers in designing for higher working temperatures, and the result in most cases will be the same, whether working stresses are modified to follow the variation of the so-called limiting creep stress with temperature, or, what in terms is strictly more defensible, the variations with temperature of stress for a given small and specific rate of creep.

I regret that I have only just seen Mr. Boulton's letter, and I hope that at this somewhat late date you will be able to give space to this communication.

R. W. BAILEY,
Metropolitan-Vickers Electrical Co., Ltd.,
Manchester, April 19th. Research Department.

BREAKWATER AT TABLE BAY.

SIR,—In an article headed "Harbours and Waterways in 1928," which appeared in THE ENGINEER dated January 11th, 1929, it is stated on page 33, column 3, in the twenty-second line from the bottom, in connection with the construction of a breakwater at Table Bay, that "40-ton sloping blocks are used, founded directly on the sea bed of firm clay." This is incorrect, as the bottom is a mixture of sand, stone and shell, overlying pure sand, which in turn overlies rock.

It is assumed that you will desire to correct this misstatement.

J. R. MORE,
(General Manager).

South African Railways and Harbours,
Johannesburg, April 3rd.

THE retirement is officially announced of Mr. Alexander Wilson, who became the divisional general manager, London and North-Eastern Railway, York, when that company was formed and Sir Ralph Wedgwood was made the chief general manager, and who subsequently came South as divisional general manager, London. He is being succeeded in the latter position by Mr. G. F. Thurston, who was the secretary to the Great Eastern, and on the formation of the London and North-Eastern Railway was made joint secretary, and later became chief stores superintendent. Mr. Thurston's return to Liverpool-street will be welcomed, as his abilities as an administrator have not, as yet, had full scope. He is to be succeeded as chief stores superintendent by Mr. A. P. Ross, now the general manager and secretary of the Cheshire Lines Committee. Mr. Ross' appointment will be very popular in engineering circles, as he is the son of the late Mr. Alexander Ross, for many years the chief engineer of the Great Western Railway and a past-President of the Institution of Civil Engineers.

Railway and Road Matters.

THE two private Bills of the London County Council and the "Underground" companies for the co-ordination of London Traffic have passed the Committee stage in the House of Commons.

THE Administrative Council of the National Railways Company, which works the old Belgian State system, has decided to equip its goods trains with continuous brakes of the Westinghouse type. A first order for 300 sets is about to be placed.

AN agreement has been arrived at between the Southern Railway and the National Omnibus Company, whereby a new company, to be known as the Southern National Omnibus Company, will take over fifty-four of the National Company's omnibus services in Devon, Cornwall, Dorset, Somerset and Wiltshire.

IT is gratifying to note that, at the end of the sixteenth week of the half year, the Great Western receipts are £13,000 more than in the corresponding period of 1928. The three other companies have decreases, but that of the London and North-Eastern is only £104,000; the Southern decrease is £127,000; and the London, Midland and Scottish is £491,000.

THE question of steel sleepers is discussed in the annual report, for the year ended March 31st, 1928, of the Indian Railway Board. The Track Standards Committee made certain recommendations on this matter which are under investigation, in consultation with the consulting engineers. The designers submitted cover sleepers for 115 lb. and 75 lb. rails for broad gauge and 60 lb. rails for metre gauge.

IT was related in this column on June 1st, 1928, that under the concession given by the City of New York to the Interborough Railway Company, the fares on the Subway must not exceed five cents per journey. The company has been anxious, in view of the depreciation in currency, to raise the maximum to seven cents, but has been prevented from doing so in view of the wording of the concession. The case eventually found its way to the United States Supreme Court where, on April 9th, judgment was given in support of the contention of the City authorities.

THE Southern Railway Company's new steamer, the "Canterbury," which is to run in connection with the "Golden Arrow" Pullman expresses, is to take up her station at Dover on May 15th. The train service between London and Paris will be accelerated. Instead of leaving Victoria at 10.45 a.m. the train will depart at 11, but will be due in Paris at 5.35 p.m. instead of 5.40, a saving of 20 minutes. The journey from Paris to London will, however, be made in 40 minutes less time. Leaving Paris, as now, at 12 noon it will be made in 6 hours 35 minutes instead of 7 hours 15 minutes.

A PARAGRAPH which appeared in the Press lately stated that the Great Southern Railways, the Great Northern Railway (of Ireland), and the Londonderry and Lough Swilly Railway had given twelve months' notice of their withdrawal from the Irish Railway Wages Board. As no explanation for this step accompanied the announcement, and as the companies' intention may be misunderstood, we would say that the letter to the unions says that the machinery for negotiating such questions is "much too complex and cumbersome to meet the purpose for which it was intended, and that it might be possible to mutually devise some scheme which would be more suitable in the interests of the companies and the entire staff."

THE steel track on the Hudson Bay Railway line from The Pas, Manitoba, to Churchill, reached the port on Good Friday. Although the track has been laid up to Churchill, however, it will be some months yet before general traffic can be handled, as much ballasting remains to be done. The final spike is to be driven in during the coming summer by the Hon. George P. Graham, former Minister of Railways and Canals, who turned the first sod of the Hudson Bay Railway. Test shipments of wheat are expected to be made from the port next autumn, though it will be 1930 before Churchill assumes that important place in the development of Canada's international commerce, which is the expectation of business men in Western Canada.

Two passenger trains have recently been concerned in accidents. Early in the morning of Monday, April 22nd, two coaches on the 9.15 p.m. Glasgow to St. Pancras were partially derailed when passing through Normanton. On the following day the 7.30 a.m. Great Western train from Plymouth to Newton Abbot ran into a goods train when near the latter station. One servant travelling on the goods train was killed. The latter accident was inquired into on behalf of the Ministry of Transport by Colonel Trench on Monday, April 29th. The signalman at Aller signal-box, which is at the foot of Dainton Bank, acknowledged that, through pure inadvertence which he could not explain, he lowered the signals for the passenger train whilst the line was occupied by the goods train.

IN view of the reference to privately-owned wagons in our leading article on Railway Reform on April 26th, it will be of interest to hear that, in reply to a question, the Minister of Transport recently stated that the number of privately-owned wagons registered at the Railway Clearing House on January 31st last, was 638,000, of which 578,000 were coal and coke wagons. Reference to the Board of Trade wagon census of August 1st, 1918, shows that the number of wagons has increased since then by 12,000, and of coal or coke wagons by 47,000. We doubt, however, the latter figure, and think it possible that in the comparative figures the 35,000 wagons used by railway companies and Government departments in 1918 should be added to the 531,000 coal and coke wagons. If so, the increase therein is also 12,000. A charge fequently levelled against the privately-owned wagon is that it is of small carrying capacity. That is not so; the above-mentioned census shows that of 384,000 wagons used by colliery proprietors only 62,000 were of less than 10 tons capacity, whilst 83,000 were of 12 tons and over. Actually, the railway companies' own aggregate wagon capacity is worse. According to the Railway Returns for 1927 they had a total of 173,385 mineral wagons, of which 70,000 were of less than 12 tons capacity.

Notes and Memoranda.

ACCORDING to the *Iron Age* a new form of hard steel is being introduced by the Detroit Steel Company. Its composition is not given, but it is said to air harden at 1650 deg. Fah. without quenching. Dies of this steel may, it is stated, be cast in intricate shapes in one piece.

A RETURN has been issued by the Ministry of Transport giving particulars of the number of mechanically propelled vehicles for which licences were current at any time during the quarter ended September 30th, 1928. The total number of vehicles of all types, including private cars and motor cycles, was 2,052,453, compared with 1,899,650 during the corresponding period of 1927.

IT is reported from New York that a company known as the Perpetual Self-Winding Watch Corporation has been organised under the laws of Delaware with a capital of 800,000 dollars, to manufacture and distribute a self-winding watch invented by Mr. John Harwood, an English watchmaker. The principle on which the watch operates is similar to that of the pedometer. While worn on the wrist it is said to be kept fully wound by the natural movements of the forearm.

THE British Commercial Secretary at Stockholm reports that the number of registered motor vehicles in Sweden at the beginning of 1928 was about 145,000, and at the end 179,000. A great increase occurred in the number of motor cycles, which at the close of the year was about 51,500. It is estimated that at the end of 1929 the number of motor vehicles will approximate 200,000, consisting of 107,000 motor cars, 2500 omnibuses, 33,000 commercial vehicles, and 57,500 motor cycles.

THE Portuguese newspaper *Seculo* states that a naval petty officer, Joaquim Manuel Palmeiro, has invented and demonstrated before the Navy Council and numerous naval officers a means of not only saving alive the crews of wrecked submarines, but also of bringing to the surface such submarines and their crews still alive. The Technical Council on Submersibles has decided that the inventor shall make a further demonstration of his invention before the officers of the submarine squadron.

PROBABLY the simplest method of avoiding trouble due to birds perching on the metal cross arms of medium-pressure overhead lines where pin type insulators are in use is to cover the arm with an insulating sleeve which is non-hygroscopic and not liable to deterioration by exposure to the weather. Porcelain and many moulded insulations comply with these requirements, but there are other factors which narrow the field of choice. The material chosen should be low in cost, not fragile and capable of being machined.

THE 160,000-kW generator which is being supplied to the New York Edison Company will have two separate stator windings, wound in separate slots. Each winding will be connected through a 10 per cent. reactance to a separate bus-bar section. The loading will be flexible, since each winding can carry 90,000 kW, provided the total load does not exceed 160,000 kW. If one winding breaks down the other can still be used. High reactance between bus-bar sections can be used without sacrifice of stability, since the two windings must always be in synchronism.

ACCORDING to a message from Fort William, Ontario, a new world's record for paper production from one machine has been achieved by the output of 151·1 tons of newsprint in twenty-four hours from the 264in. machine installed in the mill of the Great Lakes Paper Company in that city. It is stated that the machine has not yet passed the one thousand foot per minute stage, though it has a rated speed of 1500ft. per minute. Incidentally a still larger machine is being installed in the same mill, capable of turning out a sheet of paper 304in. in width. This machine is expected to be in operation in the near future.

ONE of the first duties of the Explosives in Mines Research Committee, appointed in September, 1922, was to undertake a revision of the official test of explosives for inclusion in the permitted list, the test formerly carried out at the Official Testing Station at Rotherham. An account of the Committee's labours in this connection, and of the results, is contained in a report entitled "The Testing of Explosives for Use in Fiery Coal Mines." (Safety in Mines Research Board Paper No. 51, H.M. Stationery Office, price 2s. net.) The Committee, after a long course of trials, has found that firedamp is the most suitable inflammable gas to use in the test, and, after further experiments, has formulated a new test which will give greater regularity in its results than the present test and should thus afford better means of controlling the uniformity of explosives while maintaining an ample margin of safety. The experiments have further shown the great value of effective stemming in preventing the ignition of gaseous mixtures and the Committee lays emphasis on the importance of a rigid observance of the regulations with regard to stemming. A detailed description of the new test is appended to the report.

THE supply to the Leningrad tramways has hitherto been by 600-volt direct current from rotary converters fed by the 25-cycle town supply. Increasing load has necessitated installing further plant, and it was decided to install rectifiers in preference to rotary converters when laying down new sub-stations. This decision was made on the score of the lighter foundations required, smaller first cost, quieter operation and better efficiency under varying load conditions. The total output installed amounts to 17,400 kW, the units being either of 1200 kW or 600 kW. Each 1200-kW set consists of a transformer feeding two six-anode rectifiers, while each 600-kW set consists of a transformer feeding one rectifier of the same size. The rectifiers are built as complete units with their vacuum pumps, the electrodes being sealed in the covers by mercury and asbestos rings. The rectifier cathodes are connected to the positive bus-bar *vid* a high-speed switch, while the earthed negative lead is connected to the neutral point of the transformer *vid* two voltage regulating choke coils. These choking coils resolve the secondary six-phase system of the transformer into two three-phase systems displaced by 60 deg. The current supply to each individual electrode is thus spread over 120 electrical degrees, instead of over 60 deg. as in six-phase working.

Miscellanea.

A NEW factory is to be erected at Toronto, by Ferranti Electric, Ltd., for the manufacture of transformers and wireless apparatus.

THE Consett Iron Company, Ltd., has decided to erect ten more ovens at Derwenthaugh, where its battery of Otto hairpin type ovens was put into operation in January. The ovens are supplying town gas to the Newcastle and Gateshead Gas Company, and are stated to have been an unqualified uccess.

IT has been decided by the Soviet authorities to proceed with the organisation of a State Office attached to the Supreme Economic Council for drafting plans for an artificial fibre factory, the "Stroivolokno." It has also been decided to organise the first All-Union State Peat Trust—the "Torftrest."

A COAL hoist weighing 80 tons was removed last week from the Town Dock, Newport, to the Alexandra Dock. The operation was carried out in five hours with the aid of the Great Western Railway Company's 125-ton floating crane. The removal of the hoist follows the railway company's decision to close the Town Dock. A second hoist is also to be removed.

BRITISH structural steelwork firms, in conjunction with British steel makers who roll structural steel, have recently formed the British Steelwork Association, a non-profit-earning Association, whose objective is to simplify and standardise the use of structural steel, to effect economies, and to promote its greater use to the mutual advantage of the steel industry and the public.

STATISTICS of recent imports of electrical machinery and apparatus into India broadly indicate the country's electrical progress. During the past five years the total annual value of imports of electrical apparatus, machinery and accessories has averaged 5½ crores of rupees (about £4,000,000) and has not varied more than 10 per cent. on either side of that average, excluding the many items of plant and material ancillary to electrical development.

THE plans for the electrification of Soviet Russia, drafted in 1921 on the initiative of Lenin and providing for the construction of thirty regional electric stations with 1,500,000 kW within ten to fifteen years, have now, according to the *British-Russian Gazette*, been very nearly completed. The Soviet authorities are now starting to consider the drafting of even more ambitious plans for the next five to ten years, and the possible reorganisation and extension of the Glavelectro (Chief Electrification Department), under whose auspices the original plans for electrification were drafted and carried out.

IN a recent address on "Heat Treatment from the Production Engineer's Standpoint," before the Birmingham branch of the Institution of Production Engineers, Dr. C. M. Walter, of the Industrial Research Department of the Birmingham Corporation, referred to the enormous increase in the use of gas for industrial purposes. Last year's figures, he said, showed an increase of 238 million cubic feet in the consumption of gas for the heat treatment of metals. The Birmingham gas department, he pointed out, had placed its laboratories at the disposal of manufacturers for testing methods of heat treatment.

IT has been announced by Mr. Charles A. Edison, a son of the famous inventor, that his father is looking for a young man to succeed him in the field of invention, and that he will make a selection this summer. State Governors and the Commissioners of the District of Columbia, in which the City of Washington is situated, will each nominate one candidate, and the forty-nine boys, thus selected, will be taken to the Edison laboratory, where they will have to answer a questionnaire prepared by Mr. Edison himself. The successful candidate will be sent for a four years' course to any technical college he may choose.

WE learn that the Swedish Government has placed an order with the Marconi Company for the supply of a 60-kilowatt aerial energy transmitter for installation at Stockholm. The fact that this contract was obtained by the Marconi Company in the face of keen competition is a tribute to the excellent design and performance of British broadcasting transmitters already installed in more than twenty countries outside Great Britain. The new Swedish broadcasting station will be effective over a very large area. It will be operated on the low-power modulation system, with deep and distortionless modulation, and will be worked direct off a three-phase public electric power supply.

IN THE ENGINEER of November 2nd we described and illustrated the 145ft. Diesel electric ferry boat "M.O.P. 5. B.A.," which was built for the Argentine Ministry of Public Works by Yarrow and Co., Ltd., Scotstoun. The vessel, which is to be used for ferry service on the river Parana, recently crossed the Atlantic under her own power with only one stop at St. Vincent. The electrical equipment was supplied by the Metropolitan-Vickers Electrical Company, Ltd., and the dynamos are driven by M.A.N. airless injection engines. During the voyage the machinery was in continuous operation for periods of eleven to seventeen days, thereby demonstrating its reliability for the intermittent ferry boat service for which it was designed.

THE decision of the Shanghai Municipality to accept the offer of the American and Foreign Power Company to purchase the electricity undertaking is an outstanding event, not only in view of the amount involved (£10,000,000) but also as an indication of the changing state of affairs in the International Settlement. The undertaking, states the *Electrical Review*, is a most important one, embracing installed plant of about 150,000 kW, and serving over 47,000 consumers, many of them being large industrial concerns. The output during 1927, the latest figure available, was in excess of 400 million kilowatt-hours. Although "international," the undertaking is predominantly British. The "nationality" of the generating plant installed (including a 20,000-kW set in course of erection) at the end of 1927 was as follows:—British, 81,000 kW; American, 56,000 kW; and German, 4000 kW. In addition to this, a further 20,000-kW Metropolitan-Vickers set was on order. The boiler plant is practically wholly British and so is the main switchgear.

THE HUDSON RIVER SUSPENSION BRIDGE

(*For description see page* 481)

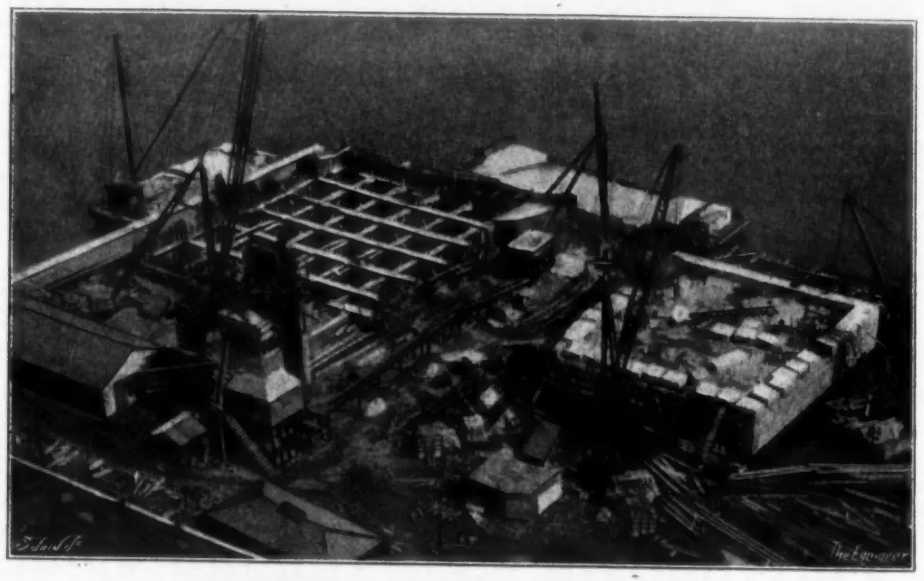


FIG. 8—NEW JERSEY FOUNDATION, MARCH 16TH, 1928

FIG. 9—BASES AND BOTTOM SECTIONS OF TOWER COLUMNS IN PLACE, AUGUST 11TH, 1928

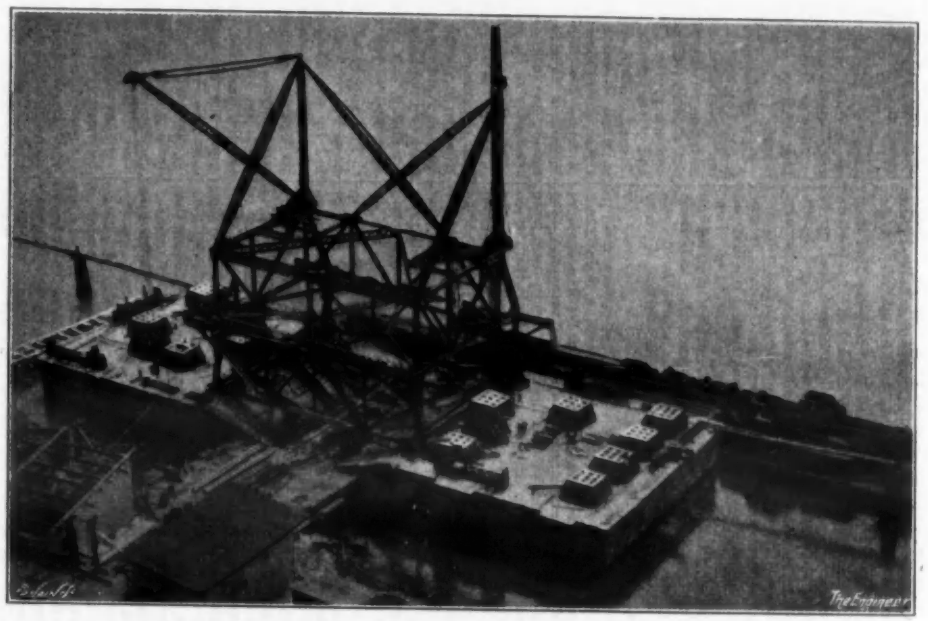


FIG. 10—ERECTION TRAVELLER PLACING COLUMN BASES, JUNE 26TH, 1928

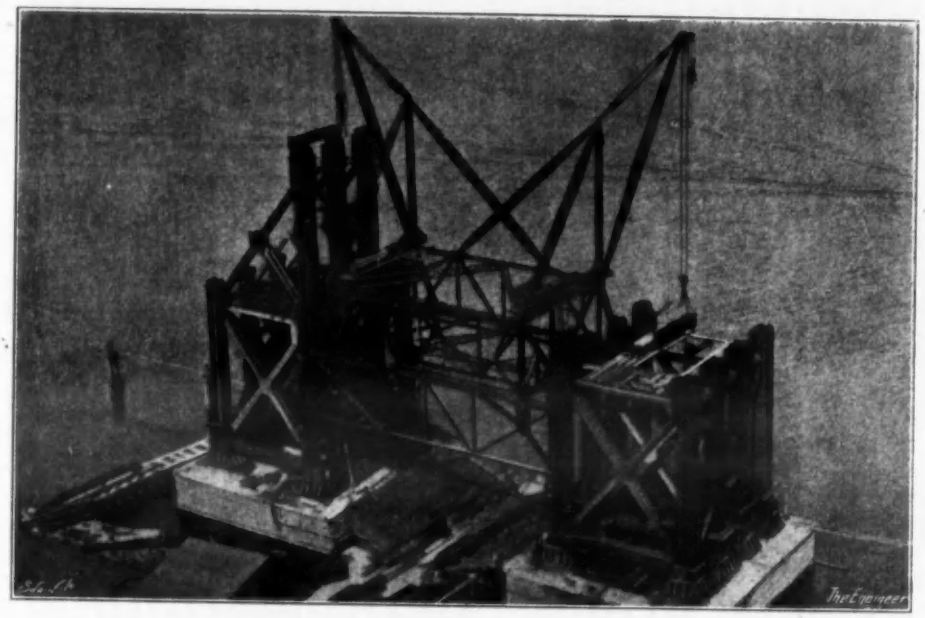


FIG. 11—ERECTING NEW JERSEY TOWER, JULY 16TH, 1928

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DEATH.

ON April 27th, 1929, at "Sudbury Croft," Harrow, ROBERT SKELTON, Assoc. M. Inst. C.E., A.K.C., Engineer to the Colombo Municipal Council (1888–1915), in his sixty-sixth year.

THE ENGINEER.

MAY 3, 1929.

The New Callendar Steam Tables.

IN publishing the new Callendar Steam Tables, extending upwards to a pressure of 4000 lb. per square inch and a temperature of 1000 deg. Fah., the Institution of Mechanical Engineers has rendered a timely service. For some years designers have been running ahead of their data with regard to the properties of high-pressure steam, and though progress may not have materially suffered thereby, a set of tables carrying our knowledge far beyond the most advanced practice of to-day is a contribution of the utmost value to steam engineering. By the generous support of the Electrical and Allied Industries Research Association, Professor Callendar has been enabled to bring to maturity, though we hope not yet to a conclusion, his investigations into the properties of steam, commenced at the McGill University some thirty-four years ago. It was then that he devised an experimental method, of which the accuracy was almost equalled by the simplicity, of determining the index of the adiabatic expansion of dry and superheated steam. Five years afterwards he published his famous equation of state which lay for so long ignored in the "Proceedings" of the Royal Society. On little more than these foundations, aided by experimental skill and mathematical intuition of the highest order, he has built up a set of equations which represent the properties of steam right up to the critical point.

The attractiveness of Callendar's fundamental equation of state lies both in the simplicity and seeming self-evidentness of its form. The trouble with all actual gases, including steam, is that their pressure for a given volume, or, alternatively, their volume for a given pressure is less than would be the case if they obeyed the ideal gas law $PV = RT$. van der Waals regarded the discrepancy as a deficiency of pressure, and accounted for it by assuming the existence of an attractive force between the molecules which partially counterbalanced the pressure they would otherwise exert. His well-known equation of state is founded on this assumption. It was a most intriguing guess, and has formed the subject of a vast amount of mathematical and physical reasoning during the last half century. It was, indeed so good a guess that it has probably been a source of more illusion than of help to physicists, for though predicting the general nature of phenomena in a wonderful manner, it has a record of consistent inexactitude when tested by experiments. Callendar took the alternative view mentioned. He considered an actual gas to differ from the ideal in having a deficiency of volume for a given pressure, and he explained this loss of volume as the result of the co-aggregation of a certain percentage of the molecules. Having determined the total heat of steam at various pressures by careful experiments, he could deduce mathematically an expression for the co-aggregation factor. This he found could be regarded, with sufficient accuracy for steam at ordinary pressures, as a function of the temperature only. His equations met with objection chiefly on the grounds that they could not possibly apply to steam under conditions of great pressure, and particularly near the critical point. They certainly did not fit in with what the objectors, bemused by van der Waals' theory, believed to happen at the critical point. It follows from this theory that at the point in question the latent heat must vanish, and the total heat of water and steam must therefore become identical. Recent experiments by Callendar have shown, however, that these deductions are not in accordance with facts. He has discovered that there still remains a latent heat of as much as 130·3 B.Th.U. per lb. at the critical temperature of 374 deg. Cent., and that the latent heat does not vanish until a temperature of over 380 deg. Cent. is attained. The present extension of his tables is based upon the results of these experiments. They have shown that his original expressions for the adiabatic expansion of steam, for the specific heat of water, and for the total heat of steam remain accurate in the critical region without any modification, and that his equation of state, when the higher degrees of co-aggregation are taken into account, satisfactorily represents the critical phenomena. His theory therefore has received an unexpected justification by the removal of the only serious objection urged against it.

Science is now so international that the publication of a new and authoritative set of steam tables must have its repercussion in many other countries. Political laws may vary from land to land, but no such latitude exists with regard to the laws of Nature, which are binding upon all nations alike. If, for example, steam expands with an adiabatic index of 1·3 in the British Empire, it must do the same in Germany and the United States. To the same questions Nature will everywhere return the same answers. But the questions must really be identical and the answers properly understood. It is here that the difficulty arises in securing agreement upon physical data. Every experimenter is limited by his own skill, by the imperfections of his apparatus, and by the errors inherent in his methods. He is tempted to over-confidence in his own results, and puts them forward, if not as absolute truth, as the nearest practical approach to it. Hence, engineers are afflicted with the nuisance of contradictory steam tables. Since, however, there can be but one truth in the matter, it should at least be possible for the responsible investigators in each country, who are seeking to attain it by different roads, to agree within small limits as to where it really lies. This is the great need of the moment with regard to the properties of steam. With such agreement we could have a set of steam tables approved by all as far as the figures went, and the debatable margin could be left till sufficient evidence had accumulated to enable further agreement to be reached. Speeches at the proceedings of the recent World Fuel Conference in London, gave grounds for belief that such a prospect was in view. It was understood—wrongly, as it turned out—that the investigators in all countries would refrain from publishing the results of their work till an effort, at least, had been made to secure their international acceptance. In accordance with this understanding, the new Callendar tables were withheld by the Electrical Research Association. The unexpected publication by the A.S.M.E. last December of some new American figures relating to the

properties of high-pressure steam made it advisable, however, that Callendar's figures should be made available as soon as possible, and the Institution has, therefore, now issued them for the use of engineers generally. This was the only thing to do in the circumstances, though the necessity for it was regrettable. It would have been better if both the American and British results had been kept back until after the forthcoming International Steam Tables Conference, to be held in London in July, when the relative merits of these and other data could have been considered by a competent international committee. As it is, things have now gone too far to render general agreement easy. It is only fair to the Americans to say that their figures were not put forward as final. Callendar's are not, either. But every table is the final one till another is compiled, and cannot help being regarded as the last word on the subject. The tables differ not by very much, but by quite enough to cause trouble. The American investigators have spent a lot of money and energy on their work, and naturally wish that it should find acceptance, desiring perhaps also, quite naturally, that it should fall to their lot to replace some of their previous well-known tabulations, which suffered from the fatal fault of thermo-dynamic inconsistency.

Callendar, it should be remarked, was the first to develop a set of equations which gave this necessary consistency, and so ensured that if any calculation referring to steam was made in different ways from his tables, the results would always agree. Self-consistency, however, though an invaluable check on the accuracy of steam tables, does not by itself constitute a proof of accuracy. If it did, Callendar would have finally solved the steam table problem years ago. The real test of formulæ is whether they fit observed facts and, judged by this criterion, Callendar's equations are quite satisfactory. They certainly accord well with reliable experimental data, but the inevitable disagreements of experimenters amongst themselves opens the door to a similar claim on behalf of other formulations. The particular strength of Callendar's position is that his equations are not of empirical form, made to fit plotted points, but are based on thermo-dynamic and molecular considerations. Thus, they do not apply to steam alone, but by an appropriate change of constants, they can be employed to predict the properties of any gas or vapour. While it is possible that further knowledge of molecular constitution and behaviour may slightly affect his constants, or even show the desirability of some small refinement in the form of his equations, it seems impossible to doubt that the ultimate formulation of the properties of steam must follow the lines he has laid down.

Meanwhile, we are faced with conflicting steam tables, and the question is, What can be done about it. It seems hopeless to expect at the present juncture that international agreement can be secured as to the formulæ which best express the properties of steam. Fortunately, engineers, as such, are not greatly concerned with the methods of formulation. What they want is as many accurate figures as the investigators can give them. Hence, we would suggest that the latter might turn their attention for the moment away from the construction of the formulæ necessary for the computation of complete tables. If they would all concentrate their efforts upon the experimental determination of facts regarding steam at a few selected pressures and temperatures, checking and cross-checking their results by the adoption of each other's methods, until both fortuitous and systematic errors had been rendered negligible, agreement ought certainly to be reached regarding the properties of steam under the particular conditions chosen. We should thus have a number of points in the steam tables at which the figures were admitted internationally as correct. This would not only be a great advance, in itself, but it would form a sort of skeleton of facts, compelling a considerable degree of consistency in all tables embodying these cardinal figures. Further progress in agreement should be relatively easy. With each point of doubt cleared up to the satisfaction of all before the next was attacked, a solid body of data would be built up upon which engineers could rely. Being developed without regard to existing pre-conceptions, it would avoid possible jealousies, and in measure as it grew in bulk it would afford surer and surer ground for the universal acceptatance of some one formulation of all the properties of steam. We commend the suggestion to the Research Associations concerned, for it is not worthy of the science of the twentieth century that men should continue to speak with different tongues where the facts of Nature are involved.

The Decay of Craftsmanship.

FOR three centuries and more the craftsmen of England had no equals. Hither there came Frenchmen and Germans and Lowlanders, each bringing some fresh knowledge of the arts or some special skill in the use of tools. The experience gained from them was grafted upon the parent stock and, just as our language has gained its wonderful adaptiveness and flexibility by absorption, so by such accretions our crafts increased in excellence and exactness. Throughout the later part of that period the mechanic and the engineer were one; the engineer who was not a craftsman was accounted nought. Such men as Nasmyth, Maudslay, Whitworth, Murdock were typical of the age. Each one of them could take the file and chisel in his hand and not only show a workman how a job should be done, but do it better than the best journeyman. Whitworth was so sure that craftsmanship was essential to the engineer that tests for skill in it were included in the examinations for his famous scholarships. Up to thirty years or so ago no one ever doubted that he was right. The young engineer took his training at the bench and was taught how to use tools. Nowadays he is taught the use of tools—which is quite another thing. It is deemed sufficient for him to see how another employs them and, as far as may be by such a superficial method, to learn something of their limitations by observation. There are even those, we regret to say, who hold that a works training of any kind is unnecessary and that a scientifically taught engineer may learn all that he needs of the practice of engineering in the workshops of a college. As though one might become an artist by spending a few afternoons per week at the National Gallery!

Evidence gained during the war, particularly in the selection of mechanics for the aircraft factories, showed with surprising clearness that none of the old aptitude for handicraftsmanship has been lost in this country. The tests that were set the young men and boys were of a kind that Whitworth himself would have approved and which even the best mechanics of a past age would have regarded as severe. In every modern works one may find a smattering of men—generally in the tool-room—who still retain the ancient mystery and still find pleasure in the exercise of it, just as one may discover, here and there, draughtsmen who feel a real delight in the production of a well-finished drawing. But taken by-and-large craftsmanship is disappearing from the engineer's workshop. The love of doing something excellently has been killed by the machine, which has robbed the man of the opportunity to show his talent and his personality. Moreover, with the movement towards greater leisure and larger amusements which characterises the times in which we live, the wages of the highly skilled workmen are insufficient for his needs, and the profits which he can earn for his employer by his skill are less than those that can be earned by a machine. Hence it has come about that, on the one side, the workman finds it unprofitable to become skilled—for unskilled workmen earn more than skilled—and, on the other, that employers introduce machinery which does not call for the exercise of more than rudimentary mechanical craftsmanship. Again, we may turn to the lessons of the war and note that there were few machine tool operations which could not be learnt by boys and girls in the course of a few weeks. These are the facts. They are the outcome of methods and circumstances. They are the inevitable result of modern methods and practices. But they are beginning to cause not a little anxiety. We have killed the supply of skilled men almost completely, but we have not, and we never shall, remove the need for an appreciable number. The better the tool the more certain it is to require skilled attention to maintain it in condition and to set it up for the use of unskilled labour. The development of new inventions and new designs, before they have reached the manufacturing stage, calls, not only for the exercise of the skilled craftsman, but for the display of the intelligence which his skill engenders. We cannot progress without skilled men; we still need real mechanics, clever with their hands as with their brains. What Murdock did for Watt others might do for modern inventors. Yet they are becoming scarcer and scarcer. We offer them little inducement to remain with us, and the best of them go abroad, many to America, where they get more respect and higher wages. Hence we lose them, and our competitors gain doubly. They become stronger by our weakness.

The position is becoming more and more serious. The danger has been foreseen for years and some effort has been made to avoid it; but without avail. Skilled mechanics are now scarcer in England than ever. The primary cause is no doubt the relative lowness of wages, but we fancy that it is in part a reflection of the tendency in engineering education to which we referred in our opening paragraph. If the leaders of industry, if the young engineers who in a few years shall take charge of factories, have lost their belief in the need of skill, small wonder that it receives but little encouragement. When, as so often happens, we see a young woman who has casually mastered a simple machine praised for the output she achieves, whereas the workman who has spent years in making himself a master of his hands is underpaid and unnoticed, we can scarcely be surprised if skill is little accounted amongst journeymen. We do not venture to suggest methods that might enable us to train and retain the relatively small number of highly skilled men that are needed by the engineering industry. That is a matter for employers and managers to consider. But, on the one hand, we would ask coming engineers, and those who are responsible for their education and training, not to look upon skill as an old-fashioned accomplishment like the "use of the globes" long since out of date; and, on the other, we would ask employers if it is not possible to distinguish in some way the skilled from the unskilled in their works. A prize offered for skill, or the bestowal of some little honour or privilege, might do more to encourage skill even than higher wages, for the best craftsmen still take a pride in their work that is greater than the love of money.

Clashing Engagements.

WE have before now had occasion to express our regret that more care is not taken by the engineering Institutions of London to avoid the overlapping of dates fixed for important meetings. An exceptionally flagrant example brings the matter to our attention once more. Amongst the notable discourses of the year are the James Forrest Lecture of the Institution of Civil Engineers and the May Lecture of the Institute of Metals. The lecturers are always eminent men, and a great many engineers and scientists desire to hear both. This year Sir Oliver Lodge is to deliver the May Lecture and Sir Henry Maybury the James Forrest Lecture. Both will deal with subjects of the deepest interest to engineers. Yet both are to be delivered on one date, May 7th! We cannot but regard it as very deplorable that such a clashing of important engagements should have occurred. It is true that the James Forrest Lecture is to be delivered at six o'clock and the May Lecture at eight o'clock, but it is too much to expect many of the same audiences to attend both. With this example before us, we, once more, urge the institutions to make renewed efforts to avoid similar overlapping of important meetings. We are well aware that the difficulties are great, but we are confident that they are not insurmountable. The interchange of provisional dates between the institutions at the earliest possible moment would go a long way to prevent such regrettable overlapping.

Literature.

Mining Subsidence. By HENRY BRIGGS. London: Edward Arnold and Co. 1929. Price 14s. net.

PROFESSOR BRIGGS has in the present work attacked very successfully an extremely interesting but complex subject, and it is probable that his success is due in no small measure to the fact that he has not attempted to minimise its very serious difficulties. As he points out, the initiation of surface subsidence, by mining operations, by the removal of a portion of a mineral deposit from beneath the crust of the earth, thus creating a void, is quite clear and perfectly well understood. The result, namely, a subsidence of the surface of the earth's crust, is also a very readily, and, unfortunately, far too often observed phenomenon. The real difficulty lies in linking up correctly the former with the latter, and in tracing the successive stages by which the extraction of the mineral ultimately causes the surface to fall in. The trouble is, of course, that what actually takes place in the intervening strata is at present unknown, and, indeed, Professor Briggs almost seems to suggest that it is unknowable. It is just possible that the latter view may be going a little too far. Our un-

doubted ignorance at present is due not perhaps to the impossibility of really discovering the facts, but to the circumstance that no really scientific attempt to ascertain them has yet been made, or, to put it in the words of Professor J. J. Rutledge, Geologist of the United States Bureau of Mines: "The 'angle of break' will be as important to the mining engineer as the 'angle of repose' is to the civil engineer, and the laws governing subsidence will be known to some extent, and coal mining will take rank as a profession," provided that a proper amount of research work is done.

Professor Briggs opens his book with a chapter which he heads "General Considerations," and which states the problem to be discussed. Incidentally, he lays stress upon a point which is often forgotten, namely, the definite distinction between surface subsidence and damage to property resulting from such subsidence. The latter is often a very serious matter, whilst the former is in many cases, taken by itself, of no grave importance, so that by an easily understood mental process the importance of the damage so overshadows the subsidence itself that the latter is often lost sight of. There is a short chapter on the Law of Support, which might, indeed, have been omitted, for it adds nothing to the full and authoritative information on the subject which is to be found in the final report of the Royal Commission on Mining Subsidence.

The next chapter presents a historical summary of the various theories of subsidence, and gives them very well and clearly. Amongst the theories considered, the author quite rightly devotes several pages to Fayol's, and sums it up by claiming that it contains a half-truth, and is, therefore, of some value. Against this view, it may be urged that there is no form of misstatement more dangerous than a half-truth. It always depends upon which half the inquirer happens to get hold of. If he happens to light on the half that is true, all may be well; but if he, as is just as probable, lights upon the half that is false, it may seriously mislead him. Professor Briggs again has done useful service in drawing attention to the valuable work done by Goldreich in his two books on this subject.

The fourth chapter discusses the various safeguards against subsidence and the effects of subsidence, and necessarily deals with these subjects somewhat briefly. The author expresses disagreement with the views on the question of hydraulic stowage expressed by the final report of the Royal Commission on Mining Subsidence. When, however, the statement in the report is carefully examined, there is seen to be practically no difference between the views there advanced and those of the author. Thus the Royal Commission says about hydraulic stowage: "Its universal adoption in Great Britain is, however, impracticable," whilst Professor Briggs says: "Hydraulic stowing must always be of limited application." The Commission states that "hydraulic stowage might, however, in exceptional cases be desirable and even economic"; Professor Briggs says about it that "the process has in many mines proved to be both profitable and safe." Obviously the measure of agreement between the two is far greater than that of difference. The next chapter discusses published British observations on Subsidence, dealing more especially with the subject of draw. It is, of course, a matter for great regret that the published British observations bear so small a proportion to the total number in existence, the majority of such observations being unfortunately pigeon-holed in the offices of mining engineers throughout the country. If it were only possible to collect all of them, our knowledge of mining subsidences would be greatly extended. The next chapter deals with observations made in India and in the United States of America, and naturally is more particularly devoted to a consideration of the view put forward by many prominent Americans, particularly perhaps by Mr. G. S. Rice, that the surface subsidence caused by room-and-pillar working does not extend beyond the mined-out area, and that the draw is zero or negative. On this point Professor Briggs states that his own opinion is that the verdict on this American claim should be "Not proven." With this view most British engineers will no doubt agree, and such disagreement with the American view was very definitely expressed by Mr. T. A. O'Donahue in his evidence before the Royal Commission on Mining Subsidence. Probably, most British mining engineers will endorse a remark made by Professor Henry Louis in discussing this matter in *Mining and Metallurgy* in March last, where he sums it up in the following words: "When I find mining engineers habitually leaving shaft pillars of smaller size in lower seams than in upper ones, I shall begin to believe in negative draw—but not until then." Careful examination of the American evidence will show that in the United States the practice, unlike that in this country, is to leave a considerable proportion of the coal in the form of pillars; thus Professor Briggs states that in the room-and-pillar workings of Illinois, "only about 50 or 55 per cent. of the seams is recovered." Again, much of the American evidence is derived from workings in which the subsiding ground has not yet come to rest, or, to use Professor Briggs' words, he considers that the evidence presented by the United States is "only a portion of a drama, so to speak, of which the last act has yet to be staged."

The three last chapters are devoted to the theory of the subject, namely, Bending and Bending Moments, Shear, and Conclusions in Regard to the Mechanism of Mining Subsidence. Under these headings Professor Briggs has endeavoured to put forward something like a coherent theory of the sequence of events between the excavation of the mineral deposit and the subsidence of the surface. Necessarily, his theory is imperfect, but his views, nevertheless, deserve careful consideration. He states in some detail Navier's theory of rupture and Mohr's theory of shear, and is apparently inclined to believe that the latter may help to explain some of the difficulties presented by the problems of mining subsidence. He lays great stress, and apparently correctly so, upon the important fact that all strata are capable of bending to a greater or lesser extent, for there is no doubt that the extent of bending—that is to say, the amount of deformation that takes place before actual rupture occurs—must play a very important part in deciding the exact nature of the subsidence. Professor Briggs rightly points out that mining subsidence is due to a combination of bending and shearing, and, in the case of particularly non-coherent strata, also to flowing, but that the majority of solid strata both bend and shear. At the same time, he fully admits that the subject is far too complex to be amenable to mathematical methods, and that the only formulas available are empirical, and that whilst they may sometimes be useful as guides, their utility is distinctly limited.

Upon the whole, it may fairly be said that in spite of the inherent difficulties of the subject, this book constitutes a distinct advance towards a better understanding of it.

Steam Turbines. By JAMES AMBROSE MOYER. Sixth edition, revised and enlarged. 1929. London: Chapman and Hall, Ltd. Price 22s. 6d. net.

WHEN the first edition of this book appeared, now more than twenty years ago, it marked a great advance on most of the turbine literature which had preceded it. The author realised that engineers needed something much more practical than the descriptions of patent drawings and triangles of velocities, which had formed the stock-in-trade of previous writers, and he therefore set himself to show how nozzles, blading and other elements of a turbine could actually be designed. The descriptive matter, too, although perhaps a little overloaded on the side of American practice, was good, and gave a useful presentation of the state of the art of steam turbine construction at the time. The book, therefore, deserved—and received—a warm welcome. Its start was good enough to warrant the hope that it would run through many editions, each re-establishing it as a practical and up-to-date guide to steam turbine design and construction. Unfortunately, like so many text-books dealing with a rapidly developing subject, successive revisions have lacked thoroughness, and the present edition reflects obsolete practice to an extent which precludes any possibility of commending it. We still have the clear print and the easy style, but in reading it we are transported back to the nearly-forgotten days when Curtis turbines were vertical; when one could say that "practically all the new battleships and cruisers for the American and British navies are now turbine driven"; when Parsons turbines had "puff-governing" and sleeve bearings; when the "Willans-Robinson Company, Rugby, England" and the "British Westinghouse Company, Manchester, England," were among the "important manufacturers of Parsons turbines"; when it was worth while to compare the floor space required for Corliss engines and vertical Curtis turbines; and when, indeed, the whole state of steam turbine engineering was rudimentary in comparison with to-day. A table of the "latest reported tests in America and in Europe" ranges between the years 1905 to 1912, no figures apparently having come to the knowledge of the author in the seventeen years which have elapsed since the latter date. One more quotation may be permitted, as it gives the whole atmosphere of the volume. Under the heading of "Steam Pressure best Suited to Turbines," we find: "Probably the most suitable operating pressure for most power plants is about 150 lb. per square inch gauge pressure (165 absolute) at the throttle valve, and, at least in plants of moderate size, a greater saving can be obtained by the use of a moderate amount of superheat than by increasing the pressure beyond this point. In large plants steam pressures of from 250 lb. to 350 lb. per square inch are not now unusual." The book is so hopelessly out of date that a seventh edition, rewritten almost from cover to cover, is needed at once to justify the reputation of both author and publishers.

Applied Chemistry. A Practical Handbook for Students of Household Science and Public Health. By C. KENNETH TINKLER, D.Sc., F.I.C., and HELEN MASTERS, B.Sc. London: Crosby Lockwood and Son. 1929. Price 15s.

THE present is the first volume of two, and is a text-book for the third year in the course of applied chemistry for those intending to sit for the newly instituted B.Sc. (Household and Social Science) degree of the London University. The lectures will have supplied the major part of the theoretical knowledge required, and although the present is primarily a practical book, a certain amount of theoretical matter has been introduced in order to make it valuable to students in other universities and training schools.

The scope of the volume is wide, covering experimental work—some of an elementary nature—in regard to water analysis, detergents, textile fabrics, bleaching agents, ventilation, fuels, paints, polishes, &c. The opening chapter on Water Analysis covers the ground pretty comprehensively on normal lines; under the heading "Soap" will be found much useful information on the chemistry of soap manufacture, as well as on the analysis of various forms of commercial soap; "Textile Fibres" are discussed with reasonable completeness; and cotton receives full consideration; whilst linen, ramie, jute and hemp are more briefly touched upon.

The subject of artificial fibres is ably handled, and a useful part of this section deals with the separation and estimation of the various fibres to be met with in a large variety of mixed fabrics. The details given here are not too well known.

Following naturally in the wake of the textiles comes a chapter on "Bleaching Agents," in which the many suitable chemicals are described and notes given for their analysis.

The subject of air analysis is dealt with as befits its great importance. Owing to the widespread attention that is being devoted to ventilation and the supply of properly purified air to the vast buildings now being erected, this is a chapter that cannot fail to give the engineer much valuable information; and the final chapter covers Materials for the Protection of Wood, Metal and Other Surfaces, though the subject of paints and varnishes is, admittedly, only dealt with very shortly. Polishes for metal, boots and furniture may be examined by the methods here described sufficiently to obtain an idea of their respective contents. The final section of the volume deals with Glazes and Enamels, giving instructions for the estimation of lead in both pottery and hollow metal ware.

SHORT NOTICES.

Alfred Schlomann's Technologisches Handbuch der Elektrotechnik und der Elektrochemie. An Encyclopædia of Electrotechnics. Distributors for Great Britain and the British Empire: Lewenz and Wilkinson, Ltd., 25, Victoria-street, London, S.W. 1. Price 45s.—This work, which is copyright by the Technische-Wörterbücher-Verlag G.m.b.H., Beuthstrasse 8, Berlin, S.W. 19, is a direct outcome of the author's illustrated technological dictionary of electrical engineering and electrochemistry in six languages, which was reviewed in THE ENGINEER of February 1st, 1929. In the present German handbook the short and crisp scientific definitions and descriptions, together with formulæ and illustrations, are somewhat expanded and are arranged in consecutively numbered columns under thirteen general headings very similar to those employed in the dictionary. There is an alphabetically arranged dictionary of words and terms which embraces 158 pages, after which comes the encyclopædic part of the book, containing 1484 columns of matter and illustrations arranged two columns on each page, each column being numbered consecutively. The ground covered is that of the dictionary we have referred to, but instead of the single term or formula being given, there is a short definite description or historical reference. The author points out in his introduction that the splitting up of engineering science into so many branches makes it increasingly difficult for students, practical men and research workers to make themselves acquainted with the terms used in all these branches. He suggests that the idea of the book is new but does not doubt that many improvements can be made, and if any readers have suggestions to put forward he will be pleased to consider them. We gather that an effort was made to include all the terms used in the German-speaking parts of Austria and Switzerland, but while some success was achieved, it is hoped that in later editions further co-operation towards this end may be obtained. There is comparatively little reference to telegraphy, telephony and wireless communication in the book, but that is because a special dictionary and encyclopædic handbook covering the science and art of distant communications is about to be prepared. The volume is the result of over ten years of careful work and research, and we can recommend it to all those familiar with the German language who wish to gain a knowledge of the many words, terms and formula used in electrical manufacturing and science.

BOOKS RECEIVED.

Vibration Problems in Engineering. By S. Timoshenko. London: Constable and Co., Ltd., 10, Orange-street, W.C. 2. Price 21s. net.

Press Tools. By N. F. Fieldsend. London: The Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, S.W. 1. Price 2s. net.

The Lure of Safeguarding. By A. S. Comyns Carr and D. Rowland Evans. London: G. Allen and Unwin, Ltd., 40, Museum-street, W.C. 1. Price 3s. net.

The Empire Municipal Directory and Year Book, 1929–1930. London: *Municipal Engineering*, 8, Breams-buildings, Chancery-lane, E.C. 4. Price 12s. 6d. net.

Workshop Practice. Volumes V. and VI. Edited by E. A. Atkins, M.I.M.E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 6s. net per volume.

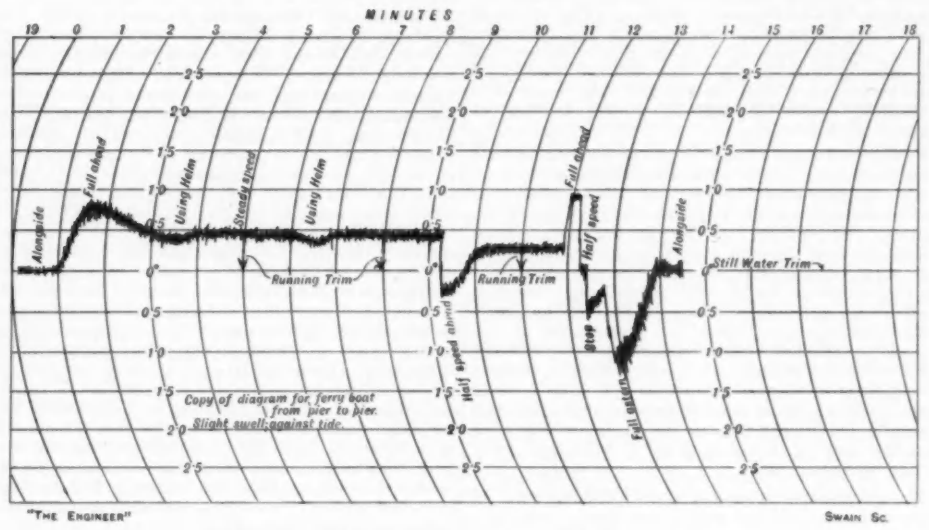
The Stabilograph.

THE instrument known as the Stabilograph, which we illustrate herewith, is designed for obtaining an accurate record of the stability of a ship, for determining the metacentric height, for measuring the natural period of rolling, the acceleration of speed, the acceleration down the slipway during launching, and the initial and sliding slipway friction. The device is made under Professor T. B. Abell's patent by Dobbie, McInnes and Clyde, Ltd., 57, Bothwell-street, Glasgow. It is applicable to any ship, and is not calibrated from details supplied by the shipbuilder. The results which it gives are permanently recorded on large-scale charts, and are, it is claimed, free from errors of observation and calculation.

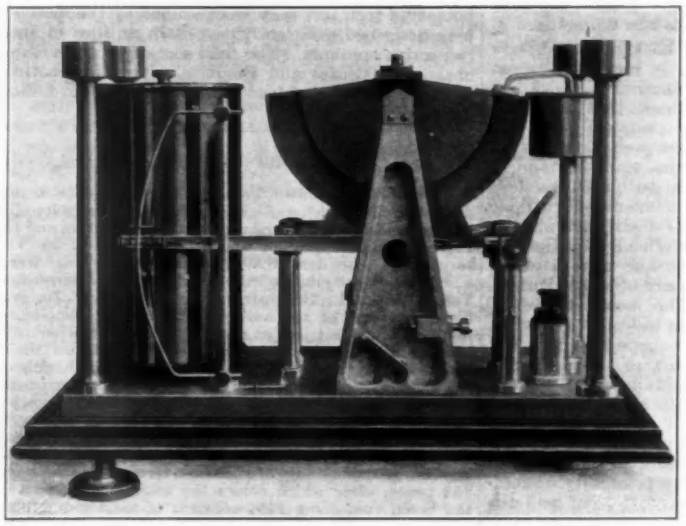
The instrument makes use of a heavy short-period compound pendulum shown at A in the line engraving. This pendulum is mounted on knife-edges at the top of the columns B. It carries a plunger C, which operates within a dashpot and damps the movement. The plunger can readily be removed from the pendulum should it not be required. The movement of the pendulum is transmitted to a pen arm D in a magnified ratio by means of a rack and pinion. In action, the pen traces a fine line on a chart held round a drum E, which makes one revolution in twenty minutes. When the instrument is not in actual use, the pendulum is lifted off its knife-edges by means of a cradle F, the movement of which is brought about by a handle G and a cam. The pen arm can be disengaged from the pendulum by lowering it on guides. This movement is effected by a cam operated by the handle H. In the engaged position this handle rests against an adjustable screw stop, by which the engagement of the pinion with the rack may be regulated. The pen, whether in a raised or lowered position, can be moved on to the paper or withdrawn from it by means of a bow operated from a handle J. It is claimed that the gear ratio between the pendulum and the pen arm, together with the almost complete absence of friction, enables accurate readings to be taken up to 3 deg. of movement of the pendulum on each side of the zero position.

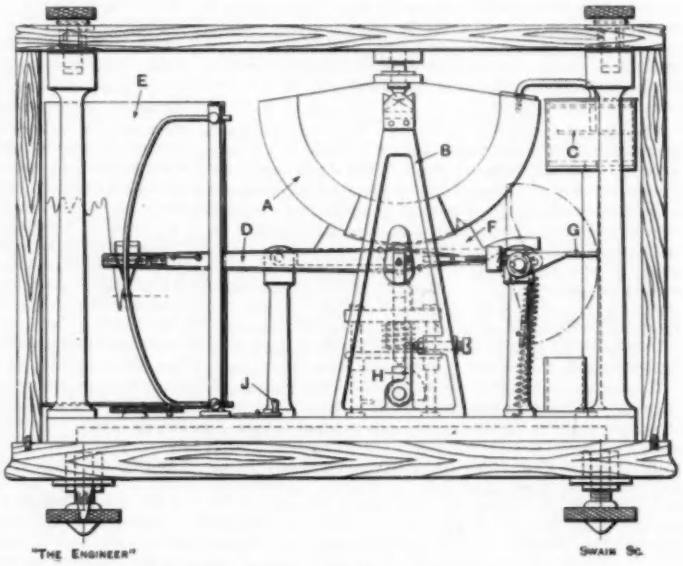
calculation or by the usual formula, the metacentric height can be determined.

The instrument is not designed to act as a rolling indicator, and should not be used for that purpose. It can, however, be employed to determine the natural period of oscillation of a ship in still water. For that purpose it is set up as for a metacentric height determination, and while the vessel is oscillating the pen is kept in contact with the paper for three or four minutes. From the wavy line drawn by the pen the average time over five or ten complete swings is measured. When the instrument is used for this purpose, the amplitude of the rolling must be small, say, ½ deg. out to out, or of that order. If the amplitude is considerable, the acceleration of the instrument rising to a maximum at the extreme out points of the roll might react on the pendulum, setting it into oscillation in its own natural period, and thereby interfering with the determination of the period of the ship. If, for example, the out-to-out roll of the vessel is 0·5 deg., if the instrument is set up 15ft. above the centre of oscillation, and if the natural period of rolling is 15 seconds, then the athwartship acceleration acting on the bob at the extreme ends of the roll would be about 0·012ft. per second per second. This acceleration is too small sensibly to affect the pendulum as an indicator of the ship's natural period. At the most it could not deflect the pendulum from the vertical by more than 0·021 deg., or, say, a twenty-fifth of the rolling angle recorded by the pen.



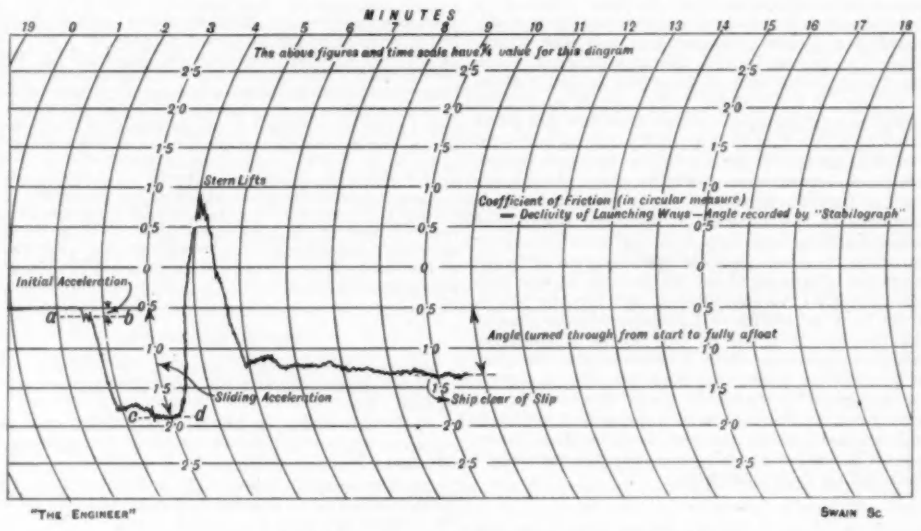
ACCELERATION DIAGRAM TAKEN ON A FERRY BOAT





THE STABILOGRAPH, AN INSTRUMENT FOR DETERMINING THE STABILITY, METACENTRIC HEIGHT, ETC., OF A SHIP

To determine the metacentric height of a vessel, the "Stabilograph" is set up, say, in the chart-house, with its long side running athwartship. The instrument need only be approximately level in the fore and aft direction, and need not be level athwartship. A weight of known amount is moved from one side of the ship to the other. The instrument records the heel produced by the known heeling moment, and from these data, either by means of a special chart provided with the instrument to eliminate


MINUTES
The above figures and time scale have ¼ value for this diagram
Stern Lifts
Coefficient of Friction (in circular measure) = Declivity of Launching Ways—Angle recorded by "Stabilograph"
Initial Acceleration
Angle turned through from start to fully afloat
Sliding Acceleration
Ship clear of Slip
"THE ENGINEER"
SWAIN SC.

THE ACCELERATION OF A SHIP DURING LAUNCHING

To determine the acceleration of a ship, as, for example, during the launching process, a high-speed drum, making one revolution in five minutes, is substituted for the standard drum. The dash pot is filled with a light mineral oil to damp out quick-period vibrations. With the instrument directed in the fore-and-aft direction, the levelling screws are adjusted until the pen is on the zero line, or until it is so situated as to allow sufficient room for the anticipated pen movement above and below the starting line.

An actual acceleration diagram taken at a launch is reproduced herewith. In this case, the recording drum was pointing aft and the pen was initially set on the line corresponding to 0·5 deg. below zero on the chart. Since the drum was pointed aft—that is, towards the bow of the ship—the acceleration of the vessel on the launching ways would cause the pendulum to swing away from the vertical towards the bow, and therefore would be marked on the chart by a downward movement of the pen. The formula connecting the acceleration and the angle of lag of the pendulum is $a = g \tan \theta$. Strictly speaking, this formula is correct for a pendulum suspended inside a body moving with uniform acceleration in a horizontal direction. If the path is inclined at an angle φ the acceleration is given by $\alpha = g \sin \theta / \cos (\varphi - \theta)$. The launching declivity φ is, however, small, say, 2½ deg. to 3 deg., and the deflection θ of the pendulum can in no case, even if friction on the ways is entirely absent, exceed the launching declivity. Hence the denominator $\cos (\varphi - \theta)$ is substantially unity, and for $\sin \theta$ in the numerator θ or $\tan \theta$ may be substituted without detectable error. In other words, the declivity of the ways may be neglected in evaluating the acceleration from the angle of deflection of the pendulum. The actual scale of the chart is such that one degree of pen movement represents 0·562ft. per second per second.

The chart reproduced shows the initial acceleration of the vessel while she is overcoming the static friction of the ways. Then follows a period of increasing acceleration until the constant value corresponding to the kinetic coefficient of friction is reached. With the entry of the

stern into the water and the coming into action of the drags, resistance is applied to the movement of the ship, and as a result, the acceleration rapidly falls off, and soon changes to a deceleration. The deceleration grows until the stern lifts off the ways. Up to this point the keel of the ship, and therefore the base of the instrument, has preserved a constant inclination to the horizontal. When, however, the stern lifts, the attitude of the ship and instrument changes. The change of attitude is such as to cause the pen to move downwards on the chart, quite apart from any change in the acceleration or deceleration of the ship. The interpretation of the diagram is therefore somewhat complicated after the stern lifts. Following a sharp descent, for which the changing attitude and the acceleration or deceleration of the ship are jointly responsible, the curve takes an almost horizontal course. This substantially horizontal stretch may, we suppose, be taken as compounded of a downward movement of the pen produced by the change of attitude of the ship and an upward movement representing the deceleration of her velocity. When the vessel is fully afloat, and has come to rest, the pen falls to a constant level below the level occupied by it before the launch began. The difference of levels between the beginning and end of the chart is a direct measure of the change of attitude, or angle turned through by the ship, during the process of launching. This angle is not necessarily equal to the declivity of the launching ways for the keel of the ship—or, more accurately, the line of the moving ways—is not necessarily horizontal when the ship is fully afloat.

From the chart it is possible to calculate the values of the initial, or static, and the sliding, or kinetic, coefficients of friction. The net acceleration down the ways is $a = g(\sin\varphi - \mu\cos\varphi)$. Taking $a = g\tan\theta$ as we may do in accordance with the approximation previously discussed, we get $\mu = \tan\varphi - \tan\theta/\cos\varphi$. Since φ and θ are both small, this expression may be written $\mu = \varphi - \theta$. In words, therefore, the coefficient of friction is represented by the difference between the launching declivity and the deflection exhibited by the pendulum, both angles being measured in radians.

A second interesting acceleration diagram reproduced herewith represents the chart obtained from the instrument when set up in a river steamer starting from rest alongside a pier, gathering speed while crossing the river and coming to rest on the opposite side. In this case, as before, the drum of the instrument was pointed towards the bow, but as the vessel moved bow first instead of stern first, as during launching, acceleration in the direction of motion is represented on the chart by a rise of the pen instead of by a fall. It will be observed that when the steamer was running at her full speed without acceleration the pen drew a horizontal line, about 0·5 deg. above the starting level of the curve. The shift is a reflection of the fact that the running trim of a vessel is not necessarily the same as her trim when stationary. It will also be noted that at half speed the trim of the steamer was about midway between her full speed and her stationary trim. The running trim, therefore, varies with the speed. In the case of this particular steamer—a ferry boat—the effect of speed was to lift her bow or lower her stern. This effect of speed on the trim must be allowed for in interpreting the chart as a picture of the acceleration and deceleration of the ship. The rise of the curve from "alongside" at the start to "full ahead" is, for instance, not wholly caused by the acceleration of the ship's velocity, but is, in part, produced by the progressive change of trim which the vessel exhibits as her speed rises. It is, too, somewhat difficult to determine from the chart as it stands whether the slight droops in the curve produced by the use of the helm are to be ascribed to a small deceleration of the ship's velocity or to a change in her trim or to both effects acting simultaneously. On one point, however, there is no dubiety. Since an increase of speed produces an alteration in the trim that will result in the pen rising, and since acceleration is also marked by a rise of the pen, there is no possibility of the curve being drawn horizontally by virtue of the change of trim effect just cancelling the acceleration effect. A horizontal portion of the curve, therefore, indicates constancy of speed. The instrument can, therefore, be used to determine whether a vessel on her measured mile trials has attained a constant speed or is still accelerating when she passes the first pair of posts. It can also be employed to determine the time required for a vessel to gather full speed from rest or to stop from full speed ahead. If the running trim is allowed for, the diagram may be integrated to give the speed of the ship at any instant, and the distance travelled up to that instant.

The Cross-Channel Motor Vessels of the Ulster Imperial Line.

IN last week's issue brief reference was made in a Journal paragraph to the three new cross-Channel motor vessels which are being constructed at Harland and Wolff's South Yard, for the Belfast to Liverpool express night service of the Belfast Steamship Company, Ltd. (Ulster Imperial Line). On Thursday last, April 25th, we were present at the launch of the third vessel, the M.V. "Ulster Prince," and later in the day we had an opportunity of making a short trip in the first of the three ships, the M.V. "Ulster Monarch." A view of this vessel is shown in the accompanying illustration, Fig. 1. The second ship, yet to be completed, is the M.V. "Ulster Queen," which is now being fitted out at the builders' yard. A large company of guests was invited by the owners to be present at the launch, and the naming ceremony was performed by Lady Read, the wife of Sir Alfred Read, managing director of Coast Lines, Ltd., and vice-chairman and managing director of the Belfast Steamship Company, Ltd. At the luncheon on board the M.V. "Ulster Monarch," Sir Alfred Read presided, and the toast of the ship was proposed by Lord Craigavon, the Prime Minister of Northern Ireland. Replying on behalf of the builders, who were represented by Viscountess Pirrie and Miss A. M. Carlisle, Mr. F. E. Rebbeck and Mr. Chas. Payne, Mr. Payne said that the strike of shipyard joiners would probably delay the delivery of the ship for about a month, and would undoubtedly modify the owner's sailing programme. He pointed out that Harland and Wolff's shipyard joiners were paid a higher rate in Belfast than that in any other yard in the United Kingdom, and that the strike had been forced upon the employers. He expressed the hope that means might be found to induce the men to return to their waiting work before the other shipyard trades were affected.

THE NEW CROSS-CHANNEL VESSELS.

The three new motor vessels now launched and in course of completion will eventually replace the existing steamers, the "Heroic," "Graphic," and "Patriotic," the first two of which were launched in 1906 and the third in 1912. In all respects the new motor ships represent a marked advance in design. By employing 6000 S.H.P. twin-screw, ten-cylinder, trunk-piston airless-injection oil engines of the four-stroke, single-acting type, it has been possible to install in a hull 345ft. between perpendiculars, 45ft. beam and 19ft. depth, with a measurement of 3760 gross tons, engines designed for a sea speed of 18 to 19 knots, and a maximum speed of 21 knots. Such propelling machinery opens a new field of development for fast motor vessels, and it is also to be used, we are given to understand, in multiple units, in ships of larger power. With the well-proportioned lines, the cruiser stern, the wide superstructure, the high bridge, and the two distinctive funnels, the new vessels of the Ulster Imperial Line present a very pleasing appearance.

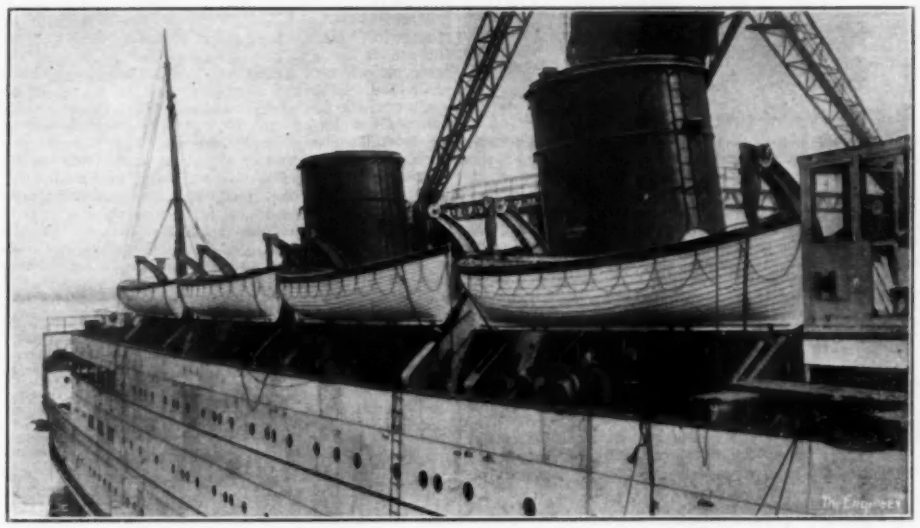


FIG. 1—THE STARBOARD SIDE OF THE "ULSTER MONARCH" SHOWING BOAT DAVITS

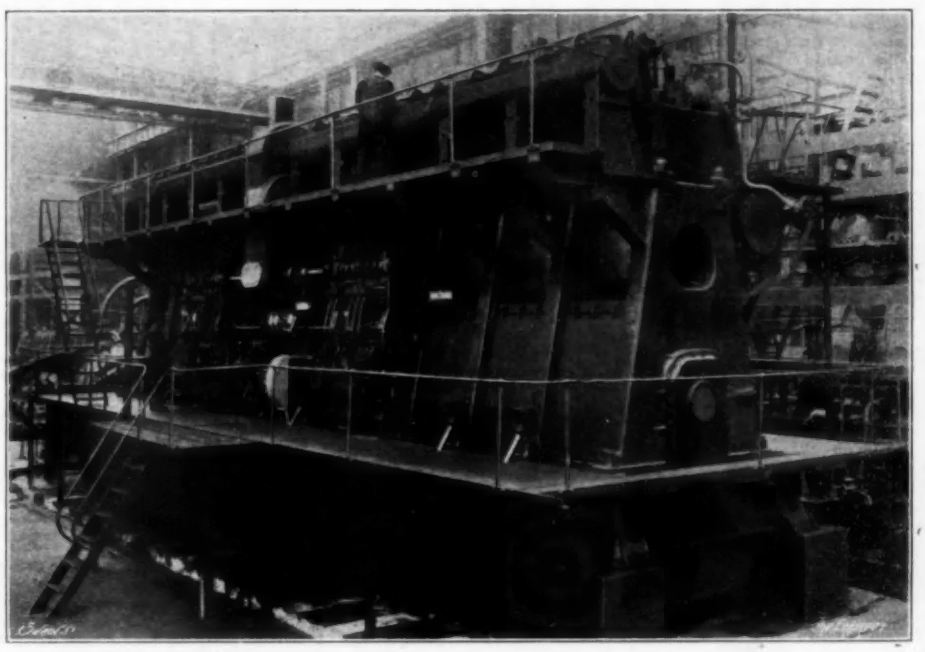


FIG. 2—THE PORT ENGINE OF THE "ULSTER MONARCH" ON THE TEST BED

While the ships are primarily intended for a night service, and considerable thought has been bestowed on the sleeping accommodation, it is evident that attention has been equally paid to the design and decoration of the public rooms, which are modern in style and very attractive.

Cabin accommodation is provided for 419 first-class and 86 third-class passengers. Over 100 first-class passengers have single-berth state-rooms, and there are four large double-berth suites, with adjoining bathrooms. The remainder of the first-class accommodation is in two-berth cabins, and in all the cabins both hot and cold water supply and electric heating and ventilation are fitted. The third-class accommodation consists of comfortable two and four-berth rooms.

The main entrance hall is on "B" deck, and it contains the purser's and night steward's offices with a telephone office with shore connections to the G.P.O. system while the ship is in port. Aft of the main entrance hall is the dining saloon, which is tastefully decorated, and on "A" deck immediately above there is a comfortable lounge. Both these apartments are the full width of the vessel. On the boat deck there is a verandah *café* aft, which is fitted with sliding glass doors, and forward is the smoking-room; both these rooms are decorated in the Old English Tudor style of a country inn.

NAVIGATING AND SAFETY EQUIPMENT.

The navigating equipment includes an electro-hydraulic steering gear, with duplicate pumps, so arranged that either can be put into service from the bridge. An emergency battery is provided, so that, in the very remote event of any failure in the main electric supply, the battery current will ensure uninterrupted operation. Other appliances include electrically operated whistles and helm indicators, revolution counters, and clear view screens. The wireless equipment is complete with a direction finder, which should be very useful when navigating in fog. Arrangements are provided to receive broadcast programmes on loud speakers fixed in the public rooms. The safety equipment includes bulkheads, which are fitted so as to divide the hull into eight compartments, while the double bottom is carried the whole length of the ship. A fire-detecting cabinet is fitted in the wheel-house, and it is arranged to give an alarm signal in case of fire in any part of the ship. In order to maintain the lighting and wireless services in the event of the main generating sets being shut down, a 7½-kW emergency set and battery is arranged on one of the upper decks. The lifeboat equipment is of especial interest, since it includes a new type of "Unaided" gravity davit, supplied by the Tees-side Bridge and Engineering Works, Ltd., of Middlesbrough. The davits carry four large lifeboats on each side of the boat deck. Our illustration—Fig. 1—shows the starboard side of the "Ulster Monarch" shortly before her completion. The davit, it will be seen, consists of two stiff built-up frames, which are bolted to the deck of the vessel and are arranged near to the ends of each lifeboat. In these frames there are housed built-up arms

to which the liftboats are fixed, and are housed when in their stowed position. When the lifeboats have to be turned out, which operation was performed in our presence, the arms operate on a fulcrum a little lower than the keel of the boat. After the boat has moved outboard 4ft. or 5ft., the bottom of the arm, which is designed to move within the frame, enters a fixed fulcrum, and the whole of the arm then turns about this fulcrum until the lifeboat is in its full outboard position. The arm then comes automatically to rest on a substantial stop on the stand.

When the lifeboat is released from its griping wires, it has a positive turning out moment, due to its own weight, and its descent is controlled by a brake operated by a weighted hand lever on the boat-lowering winch. As soon as the lever is lifted, the boat runs out to the desired embarkation level and can be lowered on an even keel until it is water-borne. The winch is of the "Herbert Morris" type, with a worm and worm wheel carried in ball bearings and totally enclosed.

The anchor windlass and capstan are both of the electric type, and are driven by 100 B.H.P. motors. They are controlled on the Ward-Leonard system. Electric winches are fitted to all the cargo hatches, and the cooking equipment is electric throughout.

Main and Auxiliary Propelling Machinery.

As shown in Fig. 2, each of the main propelling units is a ten-cylinder trunk-piston airless-injection engine of the four-stroke, single-acting, Harland-B. and W. type. Each engine has a cylinder bore of 630 mm. with a stroke of 980 mm. and has a designed output of 3000 S.H.P. at 160 r.p.m. During our trip in Belfast Lough the engines were working very smoothly at a speed of about 125 revolutions. As Fig. 2 shows, there is a stiff bedplate, with a steel sump, and the A frames forming the crank case are carried up so as to support the cylinder covers. At the front of the engine these frames carry brackets which support the cam shaft gear. The drive for the cam shaft and the two groups of fuel pumps is arranged at the centre of the engine. The fuel pumps are of a new sleeve-valve type, in which the usual suction and delivery valves are dispensed with. The reversing and manœuvring controls are grouped at the centre of the engine, and at the after end of the crank shaft there is an electrically-operated turning gear and a Michell type thrust block. Many new features are incorporated in the design, to which we hope to refer at a later date.

As the new vessels have to pass through sandy water near the entrance to Liverpool harbour, special "Cederval" propeller shaft glands are fitted. The electrically-driven auxiliary pumps are arranged in the wing spaces on either side of the engine-room and large air vessels for the storage of starting and manœuvring air are provided. All the generator and air compressor units are grouped in a separate auxiliary engine-room forward of the main engines. In this room there are installed three 110-kW oil-electric sets, driven by six-cylinder airless-injection engines of the Harland-B. and W. type. There are also two electrically driven, three-cylinder air compressors. In the main engine-room hatch there is arranged a Clarkson silencer boiler, designed to utilise the exhaust gases from the two main engines, with 80 per cent. of the exhaust gases passing through the boiler, the designed output is 4000 lb. of water evaporated per hour to steam at 80 lb. per square inch working pressure. The boiler is also equipped with the Clyde oil fuel system of oil fuel burning, which is used in port when the main engines are not working. It is estimated that by using the heat of the exhaust gases to provide steam for heating and galley use, about 1½ tons of oil fuel is saved per crossing. Provision is made to carry about 168 tons of oil fuel in various tanks.

CHEMICAL INDUSTRIES EXHIBITION IN NEW YORK.

The twelfth Exposition of Chemical Industries opens on May 6th at Grand Central Palace, New York City.

Since the World War the chemical industry in the United States has developed into the greatest of all industries, both from the points of view of the amount of capital invested in it and of the fact that practically every industry is dependent in some way on it for the production of finished products. Before the war all vat dyes used in the country were obtained from Germany and Switzerland. Preliminary figures compiled by the United States Tariff Commission show that the domestic production of coal tar dyes for 1929 will exceed that for 1927 by approximately 1,400,000 lb., and that progress in the manufacture of fast and speciality dyes has continued. In 1928 dyes of domestic production supplied about 92 per cent. of the country's consumption by quantity, and there was, in addition, an exportable surplus of the bulk low-cost colours amounting to over 32,000,000 lb.

The coming Exposition will have over 450 exhibits of raw materials, chemicals, machinery, laboratory equipment, instruments of precision, &c. The United States Government exhibit will be from the Departments of Commerce and Agriculture, including the Bureau of Mines, Bureau of Standards, Bureau of Foreign and Domestic Commerce. The first two bureaus will show results of research during the past few years, and the latter will be represented by the Chemical Division, which acts as a semi-liaison between manufacturers and the Government to promote foreign trade. The Department of Agriculture will have exhibits from the Bureau of Chemistry and Soils and the Bureau of Plant Industry, Animal Industry and Etymology. The Chemical Warfare Service will exhibit its peace-time work and what it has that is of value to industry. New York State Department of Labour will show safety work in the industrial plants, with particular emphasis on work in the chemical industries. The Exposition will, it is said, be particularly strong this year in the new ferrous alloys designed to resist corrosion. Several outstanding developments in this field will be on view, including the new Krupp Nirosta steel, which is also known as Enduro Nirosta steel, and the new Baker and Co. alloy Rhodium, which is a precious or rare metal which is used for stiffening crucibles and reducing the heat and acid losses.

Pumped Storage in Hydro-Electric Plants.

In any power scheme there arises in a greater or lesser degree the problem of balancing the input and output of the machines, and the condition is particularly in evidence in the case of water power plants. There arise seasonal variations in the amount of water available which may be met by the erection of dams to store the water against periods of drought and to conserve the excess water at low loads. This method of controlling the flow may often prove impracticable in the case of large volumes of water supplying a low head plant, and in any case it is likely to prove very costly. Sometimes the turbines are designed to utilise all but the maximum flood water and to depend for assistance during times of water shortage upon a fuel operated plant, but of recent years considerable attention has been paid to the economics of pumped storage in which the turbines at periods of light load utilise the excess water to pump a proportion of it back into a reservoir whence it becomes available during times of peak load. It is not necessary that the water so stored shall operate the same turbines which have previously handled it, and which may be, and for that matter frequently are, low fall turbines, for which it may, as already suggested, be impracticable to effect any considerable storage. The reservoir receiving the pumped water may either be an entirely artificial one, but when circumstances permit, the most favourable course is to make use of a natural lake at some high elevation for the purpose. Such conditions make for economy. In the first place the amount of water handled may be relatively small, which reduces the cost of the pipe line and the works connected with the storage reservoir, while the turbines operated by the high-pressure water would be simpler, lighter and cheaper than they would be if they were of the low fall variety. In fact, there are one or two schemes now in operation in Central Europe which make use of low fall turbines wholly for the purpose of handling high-pressure water. They are altogether of a simpler and cheaper type than would be necessary for driving generators under similar conditions, and they can be worked up to their full capacity at any speed suitable to the water conditions prevailing at the time. The high-pressure turbines, on the other hand, can always be operated at a constant head and at high speed, both conditions being suited to the driving of electrical machinery, and enabling the latter to be built at relatively low cost. Any scheme of this nature with its pipe line, pumps and extra set of turbines, must of necessity be rather costly, but the plant is of a kind which will be capable of earning considerable revenue if the works as a whole are carefully thought out and the local conditions reasonably favourable to them.

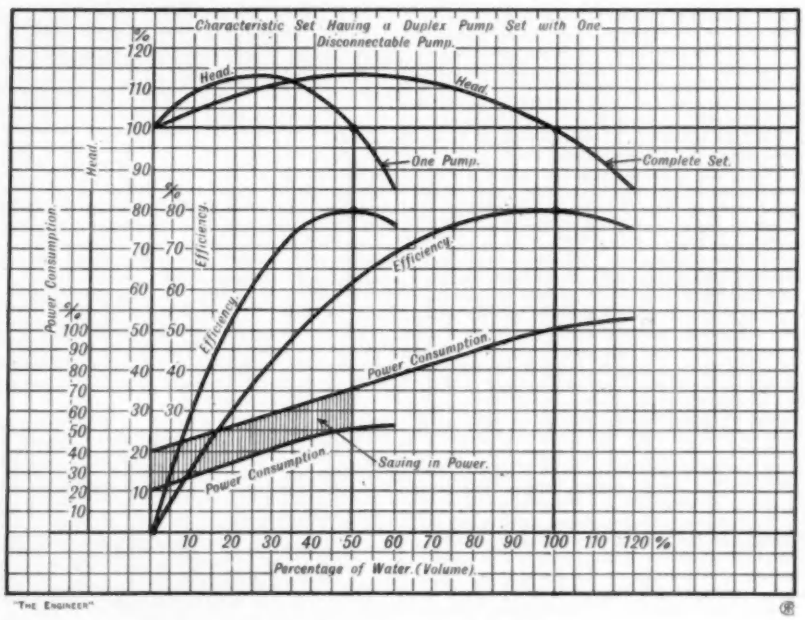


FIG. 1—PUMP CHARACTERISTICS

A Simple Scheme in Scotland.

As will be pointed out presently, this particular aspect of what may be regarded as the economics of water power has been developed principally in Central Europe, the plant is fairly comprehensive, and the engineering problems of a large scheme are by no means simple. Pumped storage, too, figures on a large scale in the Severn Barrage proposals, but equipment constructed several years ago, at the instance of Boving and Co., Ltd., at the Walkerburn Mills on the Tweed, is a good example of what can be done on the simplest lines at a very moderate outlay. These mills depended for many years on old fashioned water wheels, and when increased power was required to cope with a developing business, the owners wisely decided to obtain it by installing modern water power plant in place of stand-by fuel plant. It is a low head development, only 11ft. being available. The normal flow of water develops 230 H.P. by means of Francis turbines of the orthodox double wheel type, but as a total of 450 H.P. was required during working hours pumped storage was resorted to. An artificial reservoir of reinforced concrete was constructed on the hill side nearby. It has a capacity of 3½ million gallons, and during the time the works are shut down at night and at week ends, the low fall turbines pump back water from the tail race into the reservoir. During working hours this water is released to operate a 230 H.P. Pelton wheel, which works under a head of 900ft. Thus the whole of the power required, which is practically double that available from the normal flow is obtained from water which would otherwise flow to waste. The two low-pressure turbines set in pits are arranged to drive a generator by belt, but through an arrangement of intermediate shafts and gearing they can operate two high-pressure pumps which deliver water into the high level reservoir. At one end of the station is a Pelton wheel and dynamo operated during working hours by the stored water. Normally, the low-pressure turbines work at full load and the high-pressure set takes care of load variation so that hand control normally suffices for the low-pressure sets, and that is all that is necessary during the night, the pumping load being constant.

Large Plants: The Pumping Problem.

One of the first plants of this class of any pretentions was that connected with the electric supply of the City of Turin, Northern Italy, and known as the Lake Viverone scheme. From Lake Viverone a considerable amount of water is pumped back into another natural lake known as Lake Bertignano. The power unit is of considerable interest, as it comprises a spiral cased Francis turbine, a generator which can be run as a synchronous motor developing nearly 5000 H.P. and a centrifugal pump. The three sets are coupled through the medium of clutches, so that the motor can either operate the pump or be operated by the turbine to work as generator by means of the pumped water. In addition, the plant is so arranged that the electrical unit when operating as a motor can be brought up to speed by the turbine. When the correct speed is reached, current is switched on to it, the turbine is de-clutched, the delivery pipe is opened, and the regulating valve adjusted. In respect of the necessary control valves and other gear necessary with sets of this class, something will be said presently, but it is interesting to note that the Lake Viverone unit, which was constructed by Sulzers, has a normal duty of 23,110 g.p.m. against a total head of 466ft., the H.P. absorbed being some 4500 and the normal speed 735 r.p.m. The pipe line which, of course, serves either turbine or pump, as the case may be, is 57in. in diameter and some 2300ft. long, though part of the conduit is of concrete and 1542ft. is in tunnel.

Since the erection of this plant in 1922 others of a similar nature have been put into operation, the latest, both by Escher Wyss and Co., comprising a 10,000 H.P. set at the Schwarzenbach Power Station, owned by the Badische Landes-Elektricitäts-Versorgungs A.-G., and a 13,500 H.P. set at the Tremorgio Power Station, owned by the Officine Elettriche Ticinesi S.-A., in Bodino, Switzerland, while the power storage station, Niederwartha, owned by the Energie-Versorgung Gross Dresden A.-G., will have an ultimate total pumping capacity of no less than 162,000 H.P. The Tremorgio and Schwarzenbach plants have one feature in common in that there is only one pumping set for each plant, so that the pumps had to be designed to satisfy the most stringent requirements with regard to efficiency at partial loads owing to the fluctuations of the energy supply. In the case of the Tremorgio Station with a load fluctuating between 4000 and 10,000 kW the problem has been solved by coupling the motor generator by means of a gear to two pumps of similar design, which operate quite independently of each other, each pump being designed to deliver 5460 g.p.m. against a head of 3035ft. at a normal speed of 1000 r.p.m. Marked advantages accrue from such an arrangement, as will be seen from Fig. 1.

When employing one single pump the efficiency at half load is 62·5 per cent., and at quarter load 36·5 per cent. Assuming a full load efficiency of 80 per cent., if the pumping unit is subdivided and the one-half is switched off, the half load efficiency attains the full value of 80 per cent., while the quarter load efficiency is 62·5 per cent. The saving of power is indicated by the shaded portion of the graph. The gear loss for these large sets is almost negligible, and in any case may be neglected, since the speed of the pumps may be chosen independently, thus allowing the most advantageous hydraulic conditions to be selected for obtaining the highest pumping efficiency. The subdivision of the pump offers, too, the further advan-

tage that there is a standby set of one half the total capacity available, and the dimensions of the casing can therefore be reduced.

In the case of the Tremorgio Station, the pump is coupled through gearing to a Pelton wheel. There is a mechanical clutch which may be engaged or disengaged when the set is shut down, and one of the pumps is permanently coupled, while the other is put into or out of

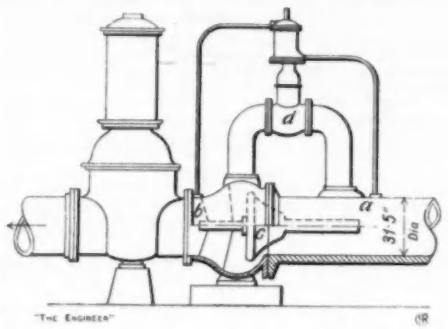


FIG. 2—AUTOMATIC PIPE LINE CLOSING VALVE

action through the medium of electrical gear. Owing to the exceedingly high head, the design of the valve gear called for special attention, since it becomes a safety device of the utmost importance. The construction of the pumps at Schwarzenbach is of interest on account of the use of adjustable guide blades operated in conjunction with a rotary valve. Each pump has two stages, the wheels being arranged symmetrically. In the centre is a double inlet impeller while at the sides are two single-eye impellers. This arrangement is, from an hydraulic point of view, an excellent one, as it enables clearance losses to be reduced to a minimum, and the glands are not subjected to pressure. The pump is also in axial balance.

The function of the adjustable blades, which can be moved from a full open to a full closed position, is to improve the efficiency at partial loads by the elimination of impact losses inherent in fixed blades under such conditions. As a consequence, too, the power consumption at starting is considerably reduced. An important feature of this design is the possibility of using the guide apparatus in place of a reflux valve when the pressure of the pump drops below that of the pipe line.

VALVES.

For the Viverone plant the conditions of contract stipulated that should the current be switched off suddenly, the momentary increase of pressure in the piping should not exceed 15 per cent. above normal. Under test this rise of pressure proved to be from 203 lb. to 277 lb., or 36 per cent., which had to be carefully investigated. The explanation is as follows:—On the current being cut off the pump slows down, and its output diminishes in proportion to the kinetic energy still remaining. There is at first a drop of pressure to about 140 lb., then an excess of pressure by about the same amount, followed by a series of pulsations gradually diminishing until only the hydrostatic pressure remains. The intensity of these oscillations increases in proportion to the velocity of the water in the pipe line, and, in the case of this particular set, after several attempts had been made to find a means of reducing this excess pressure, an automatic valve was fitted into the by-pass between the regulator valve and the pump. The arrangement is shown in Fig. 2.

On starting up the pump the dynamic pressure at *a* is greater than that at *b* on account of the frictional losses in passing valve *c*. Hence *d* will open and remain open while the pump is working. Should the pump stop valve *c* closes rapidly. Part of the water in the delivery pipe then flows back through *d*, and has the effect of weakening the force of the blow in *b* when the pressure rises. The pressure at *b* then becomes greater than that at *a*, and the valve in the by-pass slowly closes, the period of closure being regulated by a cock. The arrangement proved quite reliable and capable of keeping the pressure rise within the stipulated 15 per cent.

With centrifugal pumps of orthodox design, it is standard practice to fit a reflux valve of the flap type, but such an arrangement is entirely unsuited to the conditions under review. So long as the pump is working normally the whole column of water executes a uniform movement towards the reservoir, and when the set is slowed down this motion continues owing to inertia forces. This results in a reduction of pressure at the pump outlet. The inevitable reversal of flow will cause a rise of pressure at the same point, which it is the duty of the flap valve to prevent. Actually, by its tendency to close too late, it is suddenly thrown on to its seat, which results in an excessive rise of pressure.

This condition is made evident by the diagram Fig. 3, the upper graph showing the pressure fluctuation with a flap valve in use and the lower one without it. In the latter case the drop of pressure is about the same, but the rise of pressure only amounts to about 46 per cent. in place of about 80 per cent. In addition, the period of oscillation is considerably increased, and the damping is so pronounced that the pressure fluctuations have subsided after the lapse of twenty seconds. The results of these and other tests demonstrate the relative uselessness of the reflux valve and the necessity for providing an hydraulically controlled stop valve, which will automatically close the pipe line when the pump pressure fails so as to prevent the water flowing back through the pump and driving it as a turbine. It is such an arrangement which is outlined in Fig. 2.

PUMP CONTROL GEAR.

When movable guides are fitted, they are moved in unison by a Servo motor, which is so arranged as to close the guides automatically when the speed of the pump drops below a predetermined limit. The system, therefore,

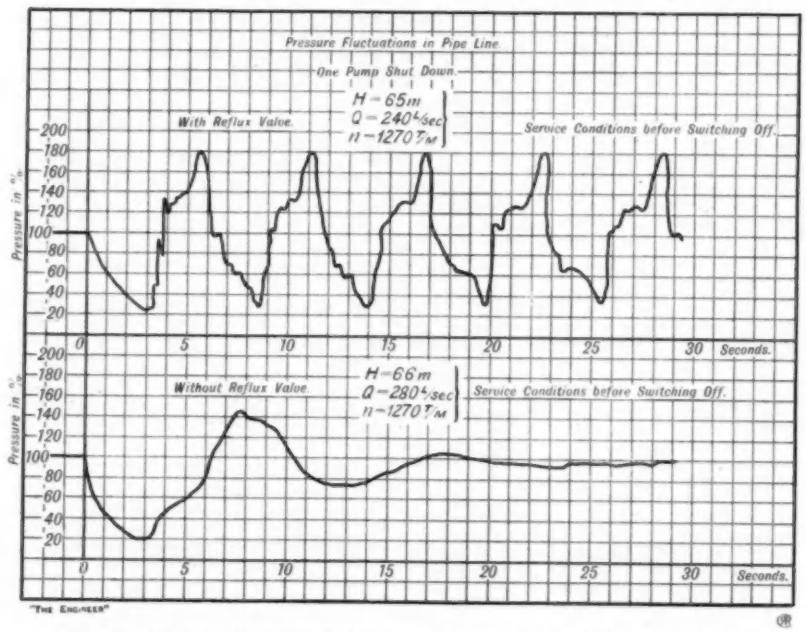


FIG. 3—PRESSURE FLUCTUATIONS WITH AND WITHOUT A REFLUX VALVE

constitutes a safety device to the exclusion of automatic valves. It is claimed to be absolutly effective in protecting the plant from the effects of rise of pressure.

Canadian Engineering News.

(From our own Correspondent.)

Engineering Standardisation.

ENGINEERING standardisation is making steady progress in the Dominion. Formed in 1919, the Canadian Engineering Standards Association now has sixty-seven working committees, whose activities are directed by a main committee of forty-nine members, the Engineering Institute of Canada nominating three of these. The funds for the Association's work consist of a grant from the National Research Council (of which the Association ranks as an associate committee), and of substantial contributions from the industries. Up to date the Association has published twenty-four standard specifications, several of which have already had to be brought up to date and re-issued. One of its most important achievements has been the promulgation of the Canadian Electrical Code, Part I. of which deals with the regulations governing electrical installations in building, structures and premises. This has been adopted officially in the Provinces of Nova Scotia, Quebec, Ontario, Saskatchewan and British Columbia, with every prospect of its adoption in the near future in New Brunswick and Alberta. The Association is proceeding with arrangements for the preparation of Parts II. and III. of this code, covering respectively specificatons for electrical apparatus and rules for outside wiring.

Among other subjects on which work is now in progress may be mentioned standard specifications for concrete and reinforced concrete, now in the Press; the revised edition of the specification for steel highway bridges; a standard list for machine screws to be discussed by designing engineers, purchasing agents, and the trade, with a view to simplification; a revision of the original specification for distribution-type transformers, rendered necessary by changes in practice since this work was originally issued eight years ago; a specification for steel castings for the guidance of designing engineers, inspectors and manufacturers, containing information on the heat treatment and testing of steel castings subject to heavy duty; and a revision of the original specifications on commercial bar steel.

New Copper Refinery.

Arrangements have been completed whereby the International Nickel Company, and the Consolidated Mining and Smelting Company of Canada, Ltd., will build a copper refinery near Sudbury, Ontario, with an initial capacity for refining 120,000 tons of copper annually. Building of the new refinery, which will cost in the neighbourhood of 4,000,000 dollars, will be begun immediately, and the plant is expected to be complete and ready for operation in about eighteen months. The hydro-electric power requirements will be about 6000 horse-power.

New Docking Wall.

Of great importance to shipping on the St. Lawrence River is the work being undertaken at present under the auspices of the Quebec Harbour Commission on the new Wolfe's Cove terminals. About 1500ft. of docking wall has been completed. This is really only the first section of the great wall, or breakwater, for when the work is completed in its entirety, it is expected to measure no less than 5000ft., and will allow a dozen steamers, freighters and liners to tie up at the same time. Other features of the harbour development scheme include the erection of a single shed 2700ft. long and 100ft. in width, and the construction of 14 miles of railway tracks on the new wharves, after which the first of three projected elevators each with a capacity of 2,000,000 bushels of grain will be built at the termini.

The Metal Mining Industry.

Development of the metal mining industry in Canada of late has been remarkable, particularly in Northern Quebec and Ontario, and had been characterised by the construction and operation to an increasing degree of smelting and concentrating plants. The mineral production of the Province of Quebec in 1928 amounted to about 34,000,000 dollars, as compared with 15,000,000 dollars in 1921. The 1928 output of gold in Ontario appears to be about equal to that of 1927. In Manitoba the power development on the Churchill River will aid in the utilisation of the very large low grade copper deposit in the Hudson Bay region. These deposits seem likely to approach in importance the Sullivan Mines in British Columbia, and the Creighton and Frooda ore bodies of the Sudbury area. The total mineral production of Canada for the year 1928 was 271,000,000 dollars, an increase of 10 per cent. over that for 1927.

Civil Aviation.

Civil aviation in Canada during 1928 greatly increased, seeing the completion of mapping 250,000 square miles by aerial surveys—an accomplishment of six years—and an extension of its use for transportation and exploration. A number of air mail contracts have been let, and it is estimated that some 3,000,000 passenger miles have been flown, and 2,500,000 lb. of freight have been carried. The Department of National Defence is ordering seventy new aeroplanes. Sixty Moths have been delivered or placed on order, and several British and American aircraft and aircraft-engine builders have established branches in the Dominion. Airports are under construction at a number of points, and the mooring mast at St. Hubert, Quebec, which is being provided for the British Trans-Atlantic dirigibles is nearing completion. During 1928 aircraft obtained records of seasonal ice formation and movements in Hudson Bay.

B.E.S.A. SPECIFICATIONS.

MINING TYPE TRANSFORMERS.

THE British Engineering Standards Association has just issued a British Standard Specification for Mining Type Transformers. It is the first of a series of specifications which is in the course of preparation for mining electrical apparatus by the Colliery Section. This Specification applies to Oil-Immersed Naturally Cooled Transformers designed primarily for use underground in collieries, and, whilst no stipulation is made on flameproofness as an essential requirement, it includes the necessary constructional provisions to satisfy the requirements of the Coal Mines Acts underground in collieries. The provisions of B.S. Specification No. 171, Electrical Performance of Transformers for Power and Lighting, are embodied. Maximum overall dimensions for three sizes of transformers, 100 kVA, 200 kVA and 300 kVA are included in order to assist colliery managers and engineers in the installation of transformers underground.

The Colliery Electrical Section has also in the course of preparation Specifications for Mining Type Motors and Generators, Flameproof Switches and Circuit Breakers, Miners' Hand Lamp Bulbs, Underground Lighting Fittings and Cable Glands and Sealing Boxes.

Copies of the new Specification (No. 355, 1929) can be obtained from the British Engineering Standards Association, Publications Department, 28, Victoria-street, London, S.W. 1, price 2s. 2d. post free.

AT the annual meeting in Melbourne on April 18th, of Amalgamated Zinc (de Bavay's), Mr. Montague Cohen, the acting chairman, stated that most, if not all, the technical problems associated with the manufacture of paper from Tasmanian hardwood had been solved. The economical and commercial aspects of the enterprise were receiving the closest attention and experimental work was still continuing.

BRITISH RAILWAY RESULTS IN 1928

THE annual reports of the railway companies are now presented in a slightly different form than in past years. They are based on the schedule attached to the Railway Companies (Accounts and Returns) Act, 1911, and, under powers given in the Railways Act, 1921, were amended slightly and now, by the same authority, supplemented by Statutory Rules and Orders, 1928, No. 1041, they are further altered. One of these changes is the inclusion of "general charges" in the tables relating to "other businesses;" that has been necessary because of the requirements of the Railway Rates Tribunal. Another innovation is a separate table for the receipts and expenditure in respect of road transport; that, of course, is a consequence of the companies' new road powers. A third change, and one of particular interest to engineers, is the inclusion in Abstract B of all the items relating to rolling stock instead of having three separate abstracts for locomotives, carriages and wagons. A new departure, also of interest to engineers, is that the statistical return as to the number of locomotives under each wheel type now has to give the total weight, empty, of each type.

The accompanying tables have been prepared from the reports for 1928 which the secretary of each company has, in continuance of past favours, been good enough to send us. The figures may be said to speak for themselves, and all we need say is that the remarkable ability of the officers of British railways was never better shown than in their saving last year seven million pounds to meet a loss of nine millions. The figures are exclusive of any transfers from or to reserve funds.

TABLE I.—*Receipts and Expenditure.*

	London, Midland and Scottish.		London and North-Eastern.		Great Western.		Southern.		Four grouped companies.	
	1928.	1927.	1928.	1927.	1928.	1927.	1928.	1927.	1928.	1927.
	£	£	£	£	£	£	£	£	£	£
Receipts.										
From railway working, passenger	29,779,779	30,475,254	19,584,971	20,220,900	13,059,007	13,281,359	17,133,574	17,132,124	79,557,331	81,109,637
From railway working, freight	43,410,102	46,721,952	34,039,688	36,020,815	17,177,442	18,245,349	5,597,625	6,195,182	100,224,857	107,183,298
From railway working, miscellaneous	680,191	619,568	488,203	485,331	249,171	256,795	288,191	276,079	1,705,756	1,637,683
From railway working, total	73,870,072	77,816,774	54,112,863	56,727,046	30,485,620	31,783,413	23,019,391	23,603,385	181,487,946	189,930,618
From other business	8,887,991	8,515,828	7,311,096	7,574,396	5,041,924	5,295,599	3,497,514	3,469,548	24,738,515	24,855,371
Gross receipts, total	82,258,063	86,332,602	61,423,959	64,301,442	35,527,544	37,079,012	25,516,895	27,672,933	205,726,461	214,785,989
Expenditure.										
On railway working, ways and works	7,961,550	7,945,081	5,988,345	6,000,297	4,018,905	3,979,593	3,391,613	3,317,725	21,160,413	21,242,696
On railway working, rolling stock	10,052,896	10,704,888	8,501,899	9,367,991	4,082,340	4,106,845	2,910,235	3,013,567	25,537,370	27,193,291
On railway working, locomotive running	14,219,642	15,283,707	10,262,754	11,514,817	5,534,087	5,881,682	4,289,132	4,777,333	34,305,615	37,457,539
On railway working, traffic	21,302,839	21,685,619	15,098,364	15,560,549	8,186,621	8,298,737	5,773,454	5,880,483	50,361,278	51,425,388
On railway working, general	5,608,509	5,867,659	3,479,795	3,666,515	2,654,491	2,744,318	2,092,568	2,214,814	13,835,363	14,493,296
On railway working, total	58,945,437	61,456,954	43,331,158	46,110,169	24,476,445	25,011,175	18,447,002	19,203,912	145,200,042	151,782,210
On other businesses	8,642,066	8,842,828	7,406,971	7,555,677	4,931,726	5,005,093	2,695,109	2,702,377	23,676,872	24,105,975
On whole undertakings, total	67,587,503	70,299,782	50,738,129	53,665,846	29,408,171	30,016,268	21,143,111	21,906,289	168,876,914	175,888,185

TABLE II.—*Details of Main Items of Engineering Expenditure.*

Way and works.										
Roads, bridges and works	998,727	1,093,419	859,438	891,075	543,550	480,724	505,926	532,569	2,907,641	2,997,787
Permanent way	4,634,700	4,547,892	3,578,810	3,473,688	2,208,952	2,146,949	1,961,277	1,879,431	12,383,739	12,047,960
Signalling	607,780	618,329	584,411	566,855	342,895	323,008	441,320	313,506	1,976,406	1,821,698
Telegraphs and telephones	176,808	199,497	146,624	148,965	89,889	97,354	56,226	82,992	469,547	528,808
Electric track equipment	33,100	20,798	17,677	10,112	2,421	2,052	690,359	56,754	743,557	89,716
Buildings	1,145,923	1,259,416	839,310	749,943	528,508	550,689	517,188	804,401	3,030,929	3,364,449
Rolling stock.										
Locomotives	4,495,822	4,745,638	4,150,287	3,960,148	2,254,809	2,073,036	1,139,728	1,193,619	12,040,646	11,972,441
Electric rail motor vehicles	200,642	204,895	18,943	17,553	6,622	7,614	596,202	333,647	821,810	563,709
Coaching stock other than above	2,461,782	2,783,887	2,063,277	2,540,932	1,200,704	1,218,828	938,934	879,197	6,664,697	7,422,844
Wagons	2,637,785	3,474,802	2,854,896	2,840,922	716,412	876,837	433,189	522,995	6,633,282	7,715,556
Locomotive running expenses.										
Wages, steam trains	8,267,455	8,638,507	6,454,254	6,686,780	3,515,353	3,570,446	1,952,526	2,008,139	20,189,588	20,903,866
Fuel, steam trains	4,743,324	5,382,061	3,415,939	4,384,556	1,791,541	2,080,033	1,423,183	1,868,750	11,373,987	13,715,400
Wages, electric trains	81,398	79,303	15,592	14,946	4,266	4,249	142,415	126,248	243,671	224,746
Current, electric trains	369,916	376,528	42,465	44,550	38,472	44,776	542,624	507,206	993,477	973,060

South African Engineering Notes.

Platinum Production.

AT present the monthly production of platinum from the three mines at present producing—viz., Ouverwacht Platinum, Ltd., Lydenburg Platinum Areas, and Potgietersrust Platinum Company—is just 1800 oz., worth £23,500. There will soon, however, be a very substantial addition, and before the end of the year a production of about 4000 oz. per month may be looked for, representing at the present price of the metal a total annual production of £624,000. The Platinum Exploration, Ltd., properties in the Rustenburg district are turning out to contain some of the richest and most extensive platinum deposits yet opened up in the Transvaal. According to last report, three inclines had attained depths of 387ft., 245ft., and 474ft. respectively, and drives had attained lengths up to 120ft. The high and regular values met with in the upper part of the inclines have been fully maintained at depth. From the No. 7 incline—between 190ft. and 230ft.—nine samples gave an average of 16·2 dwt. for the upper 12in. and 0·37 dwt. for the lower 18in. No. 9 incline—between 430ft. and 450ft.—five samples gave 19·8 dwt. for the upper 12in. and 1·9 dwt. for the lower 18in. No. 1 West drive off No. 9, five samples gave 18·9 dwt. for upper 12in. and 2·6 dwt. for the lower 18in. No. 1 East drive off No. 9—between 75ft. and 95ft. —five samples gave 26·1 dwt. for the upper 12in. and 0·4 dwt. for the lower 18in. The results are gratifying, as they indicate the possibility of maintaining by narrow stoping and sorting a very high milling grade. It is estimated that it should be possible to maintain all over the mine a grade of 10 dwt. over 15in. At a very early date a plant will be ordered which should enable a recovery of about 800 oz. per month to be made for a start, to be increased before the end of the year.

The Potgietersrust Platinum, Ltd., is at present working only its Potgietersrust properties, but a plant is at the moment being designed for its Rustenburg properties, and should be ready for preliminary runs by the end of September or early in October, and a production of about 1000 oz., to be increased later, is calculated upon from this source.

Railway Signalling Installation.

Tenders have been invited for a complete new signalling installation for the new Johannesburg railway station. The Cape Town suburban system has been equipped with three-aspect day colouring signalling, which has been reported on most favourably. The third aspect, yellow, is not suitable for Johannesburg, particularly as is would be out of uniformity with signalling along the reef on either side of the station. With the scheme which has been decided upon, two aspects only will be employed. The "home" signals normally will show a red light, which will be changed to green when the line is clear at the far end of the platform. If the train has only to proceed to the intermediate signal, half-way along the platform, a small green light, or "calling-on" signal, will be shown below the red light. A further simplification of the present system is the introduction of "route indicators." Instead of a semaphore arm and light for each separate road, which would mean having fourteen separate home signals at each end of Johannesburg, there will be only two "home" signals, one for the "slow" line and one for the "main" line, but each "home" signal will have a "route indicator" showing illuminated numbers to correspond with the number of the platform to which the train is to be admitted. The lever frame will comprise 143 levers, and in the cabin will be provided a signal diagram which will indicate to the signalman exactly which lines are occupied by trains. Each track circuit is to be illuminated separately, and as a train passes through the station the diagram will show the passage of the train from one track circuit to another. By this means, although the train may be out of sight, the signalman will know, from the illuminated diagram, whether the train is moving along or standing on any particular track circuit. The whole of the track will be track circuited, and all levers will be track locked, so that as long as a train or a detached vehicle stands on any particular track circuit, the signalman will be unable to pull off a signal for that line. All points will be triple-detected, that is, no signal can be given for a train to pass over the points unless both blades of the switch and also the bolt lock are in their correct position. Shunt signals will be provided for movements other than those provided for by the main running signals.

German All-steel Houses for S.A.

A South African company has placed in Germany an order for twenty-one all-steel houses, which will be erected this year. The average price c.i.f. Cape Town and Durban is £380 per house.

The Richest Rhodesian Copper Mine.

It would appear from the remarkably high values which have been, and are being, found in the Kansanshi copper mine that it is going to be the highest grade copper mine in Northern Rhodesia—certainly no values approaching those being obtained at this mine have been found elsewhere in that country. They run right alongside the best that the rich Congo mines can show. It is believed that it is also going to disclose an enormous tonnage, and well-informed people, outside the mineowners and officials, are already declaring their belief that it will become one of the most important producers of copper in the world. The mine is situated some 6 miles south of the Congo boundary, and the Tanganyika Concessions has a large interest in it through a subsidiary.

Before the war the mine produced 3250 tons of copper between 1908 and 1914, and exploratory work was resumed in 1927. The firm of Sir Robert Williams and Co., London, has made a report which shows that the mine contains a series of parallel reefs, of which the chief are named A, B, C, and D. Actual development work has been done, mainly on the 150ft. level, and good widths and very high values have been disclosed—in fact, are the rule. In addition, there is a dolomite ore body on which development has been done on this 150ft. level. The boundaries of this deposit are irregular, and the width has varied from 25ft. to 95ft. with an average value of 15·3 per cent. copper, which compares with an average of about 4 per cent. shown by other Northern Rhodesian copper mines.

Other deposits in the Kansanshi property are also receiving attention with promising results. Although no estimate of ore reserves is made, the width of the reefs and the high values suggest that large quantities of payable ore have already been developed, and further work now in progress will probably reveal ore extensions not yet indicated. The pyritic schists are a new feature and, if this ore extends over a large area, it may in itself provide a considerable copper output. The very high copper value shown in some of the reefs—such as the sulphide reef with 43 per cent. copper—as also the fact that the reefs are all gold-bearing, are distinctive features, differentiating the Kansanshi from other Rhodesian mines, and the results of the development work to date are very satisfactory.

New Rhodesian Copper Railways.

Recent developments at the Mufulira copper property (Rhodesia) have been so encouraging that the Rhodesian Selection Trust, Ltd., is seeking power to build a railway line from Mokambo Siding to the mine. An ordinance for that purpose is to be introduced into the Northern Rhodesia Legislative Council. By this ordinance the company is to be authorised to build, maintain and work a line of railway from Mokambo Siding to Mufulira.

In all probability it will not be long before the Kansanshi copper mine, which is opening up so well, as has just been pointed out, will be wanting railway powers. The construction of 70 miles of railway, to the Prince Leopold Mine on the Congo Rhodesian Border, would connect Kansanshi with the Katanga Railway system, and in 1930 with the Benguella Railway and Lobito Bay, thereby saving some 3000 miles of land and sea compared with shipments to Beira on the East Coast.

The Roan Antelope Mine has already finished its railway, which joins the main line near N'dola, and trains are being run over it three times a week. The length is somewhat over 23 miles.

Branch Line Losses.

According to figures laid before Parliament in the last week of the session, few of the branch lines of the Union Railways are paying. The figures are in respect of branch lines with a total open mileage of 3809, built at a capital cost of £18,682,000, or an average of £4905 per mile. The total earnings over all of these lines for last year were £1,596,989, while the working expenditure was £1,422,612, thus giving a working surplus of £154,377. These figures, however, take no account of the interest charges on the capital sums expended, which amount to £743,814, so that there was an ultimate deficit of £589,437. The largest number of unpayable lines is to be found in the Cape Province, where of twenty-four branch lines, two only, namely, those from Erste River to Protem and Amabele to Umtata showed a profit. The loss on the Hutchinson–Calvinia line was £62,349, that on the Port Elizabeth–Avontuwr line £62,504, and on that from Kraifontein to Bitterfontein £45,504. None of the nine branch lines in the Orange Free State showed a profit, but, on the other hand, there were no very heavy losers. In the Transvaal only two of the ten branch lines ran at a profit. The loss on the Belfast–Steelpoort line was £27,357, and that on the Melspruit–Greskop £18,921. There was only one paying branch line in the whole Province of Natal, while the running of the Napier–Kokstad line revealed a deficit of £44,493, and that from Matubatuba to Gollel a deficit of £32,133. In South-West Africa two of the four branch lines revealed a small profit, but on the others the loss was fairly considerable. These figures do not include the losses on any of the suburban lines, and when those are taken into consideration the annual loss on unpaying lines reaches near three-quarters of a million. The question

is bound to be raised in the near future whether some of these lines should not follow the fate of the Sea Point Railway and be scrapped. The position with regard to the branch lines, so far from showing any improvement over the figures published some years ago, is, on the whole, slightly worse, and with the increasing intensity of the competition of road transport under private enterprise, which tends more and more to skim the cream of the highly-rated traffic, the position of the railways is likely to be worsened rather than bettered.

Better Coaling Appliances.

The transporters which have been in use for years in the battery site at the Cape Town Docks, where coal for bunkering is stacked, are to be dismantled and replaced by four modern cranes fitted with grabs for the quicker handling of coal, both in off-loading the trucks on arrival from the mines, so releasing the vehicles for further employment, and for loading the trucks which are reserved for docks' use only. The four electric cranes which are to be installed are of the Clyde pattern.

Method in Invention.

IN an informal paper given recently to the Institution of Electrical Engineers, Mr. C. Turnbull, of Tynemouth, described his method of inventing by the use of Operators. He said: "The difficulties in inventing are, to a large extent, psychological. The inventor has to persuade himself to look at old ideas with a new vision, to pretend that he is looking at them for the first time in his life and to criticise them accordingly. How do inventors get their ideas? Obviously, this is one of the most important subjects that learned societies can investigate and discuss, but actually it is hardly ever mentioned in technical circles. The subject of invention is like the drawing-office at the beginning of the present century, the one place in an up-to-date works that showed no progressive tendencies, the place that was content to jog along in the good old-fashioned way that suited our fathers. The time is long overdue for investigating the whole subject of invention and for placing it in a reasonably civilised position. Twenty years ago I put forward a paper in which I set forth the Operators which are dealt with in this paper, but the paper did not get across, as our theatrical friends say, and it might as well have never been written for all the effect it had. Yet twenty years' use of the Operators has proved conclusively that the ideas are fundamentally workable, and that it is not at all difficult to invent new things by them—although, of course, it is not much use an outside inventor trying to introduce ideas in England—nevertheless, it is interesting to invent things and then to watch them come into use, generally from abroad.

"The Operators which I have set out below are devised for this purpose, and anyone who cares to try them will find that they will fulfil this object after reasonable skill has been developed in their use. In practice, I have not found anyone yet who has been at the trouble to obtain such skill. The results look so easy that people always believe that the idea was obvious all the time. The notion that an idea was obvious before it was discovered, or would have been obvious if the person had only given some thought to it, is very common and does not arise from excess of wisdom.

"The headings set out below, which I have called Operators, are used for suggesting ways and means by which new ideas may be obtained. Instead of waiting for chance inspiration, the inventor takes the Operators, one at a time, and applies them to the problem under consideration with the hope that something may turn up which may be of use. After a little practice their use becomes easy and automatic, and soon one cannot turn over a technical journal without seeing frequent instances of their application.

"In practice, the Operators overlap; the same ideas are suggested by several Operators. This is advantageous and results in flexibility. The day will come when large firms will employ a staff of trained men to work out variants on ideas. Most of the variants will be found useless, but the occasional good one will compensate for the host of wasters.

"The following is the list in a preliminary form. Further developments will come with use.

1. The Preliminary Operator.
2. The Analytical Operator.
3. The Least Loss Operator.
4. The Equivalence and Indirect Operator.
5. The Change of Position Operator.
6. The Addition Operator.
7. The Omission and Direct Operator.
8. The Change of Proportion Operator, including Increased and Decreased Function.
9. The Separation Operator.
10. The Combination Operator.
11. The Transference and Analogy Operator.
12. The Converse and Inverse Operator.
13. The Freedom and Restraint Operator.
14. The Relay Operator.

"I do not suggest that the above is the best possible selection, but I give it as a first approximation.

"There are three steps in invention:—

1. To make it work, somehow, no matter how inefficiently.
2. To make it work well.
3. To make it work well and cheaply.

"The inventor is often troubled by an unwillingness to begin at the beginning; that is, to get some kind of an idea to work on, no matter how crude. Once one gets a machine to work in some kind of a way, it is possible to go ahead with the operators and to deduce new ways of doing it, some or one of which may some day prove practicable."

Mr. Turnbull then described in some detail how the various Operators are employed.

A COPPER refinery is to be organised at Sudbury, Ontario, at a cost of 4,000,000 dollars.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Market Position.

THE week has seen no change of moment in the general condition of Midland and Staffordshire iron and steel industries. Neither have there been any marked developments in the various engineering branches. Steady progress is being made in practically all departments, and the weekly meeting in Birmingham of producers and consumers of iron and steel was well attended. Purchases were numerous, but small, and were made, for the most part, at recent prices. Constructional and motor engineers are buying more freely as are manufacturers of nuts and bolts. Bridge builders in this district are not well employed, being less successful than their competitors on the coast in securing large contracts. Staffordshire industries allied to the shipbuilding trade are becoming more active, but there is still plenty of room for improvement. There are indications of a recurrence of continental competition in some branches of the market. Steel bars and strip were the materials chiefly offered on 'Change in Birmingham to-day—Thursday. The recent rise in native makers' prices has evidently been closely followed by foreign competitors who think the time has now come to step in and secure, if possible, business at more remunerative rates than they were able to obtain for their material a month or two back. So far the market position has not been influenced by this development, makers in this district adhering strictly to their recent quotations.

Pig Iron Adjustments.

North Staffordshire makers of pig iron have agreed to reduce the selling price of No. 3 foundry iron in order to place it on a new relation with iron produced in other districts. For a little while past North Staffordshire iron has stood as high as £3 15s. per ton, but it is now to be sold at £3 13s. 6d. delivered into the Black Country. Derbyshire and Northamptonshire blast-furnacemen maintain the new price levels despite the fact that there is, at the moment, no bulk buying of iron. Foundries appear to have covered themselves over a fairly lengthy period, and the business now being put through relates only to small tonnages for immediate delivery. All blast-furnaces do not seem to be faring alike, for while there are reports of accumulating stocks at some, others report no difficulty in disposing of the whole of their output. Notwithstanding the recent increase in production of basic pig, the shortage continues and there is talk here of diverting furnaces from the production of foundry grades to the production of basic. I have been unable to trace any definite developments in this direction up to now. The conversations in this respect are, however, significant. Forge irons are selling slightly more freely at the agreed figure, 4s. per ton below corresponding foundry grades. Midland forges and foundries are fairly engaged, but could do with a large increase of business.

Finished Iron.

The Staffordshire bar iron mills are running more regularly, both as regards the production of marked and Crown qualities. A steady demand exists for marked bars at £12 per ton, and there is an increasing call for Crown bars, which have recently stiffened in value, being now quoted £9 12s. 6d. to £10. The revival in the shipbuilding industry is responsible for some activity at the Black Country chain and anchor works, and more iron is being called for in this connection. Nut and bolt and fencing bars sell slowly, local makers of these goods favouring steel or continental No. 3 iron on account of their relative cheapness. Staffordshire makers of these bars state that it is impossible to drop the price below to-day's level of £8 12s. 6d., while consumers assert that it is equally impossible for them to pay this price and still compete with those who use cheap foreign material. The call for tube strip is maintained, and prices are very firm at £10 17s. 6d. An increased use of wrought iron tubes in the future is confidently looked forward to by Midland makers.

Steel.

Steel output is expanding steadily. The higher prices required by continental competitors and the difficulty in obtaining quick delivery are causing an increasing proportion of consumers' orders to be given to native steel works. Constructional engineers are not absorbing the quantity of material expected of them, but they express the hope that present enquiries will take concrete form, in which event they will become better customers. They appreciate the efforts made by steelmasters to keep prices at recent levels. Angles and joists sell at £7 17s. 6d.; tees at £8 17s. 6d.; and ship, bridge and tank plates at £8 12s. 6d. There is a moderate demand for boiler-plates at £9 15s., and for Staffordshire hoops at £10 at works. Small steel bars remain on a high level. There are few sellers who are prepared to accept £8 5s., and practically all quote £8 10s. to £8 15s., though many sales are effected at below this latter figure. Birmingham shippers are offering foreign steel bars at £7 5s. delivered, and more attention is now being paid to these offers. Native steel strip is also making a good figure, £8 7s. 6d. to £8 10s. being commonly quoted. Billets are relatively difficult to obtain, and many makers ask £6 12s. 6d. There are others willing to sell at £6 10s., and South Wales makers and some Birmingham merchants are prepared to accept £6 7s. 6d. Continental billets are unattractive, values ranging from £6 1s. to £6 3s. 6d., according to size.

Galvanised Sheets.

There is a steady flow of small orders into the galvanised sheet mills, but the absence of large overseas orders is causing some concern. Makers in this district are able to keep going, but substantial business is needed to put order books back on a level with their standing a month or so ago. Values have not depreciated further, 24-gauge corrugated sheets being quoted £13 7s. 6d. to £13 10s.

Scrap.

The scrap market remains active, and there appears to be no easing of the shortage. Sellers in this district certainly control the position, and do not hesitate to turn down all offers which do not come up to their idea of values. They want at least £4 per ton delivered South Wales. In some quarters it is thought the turn of the market has now been reached, and many buyers hope to secure supplies at lower rates in the immediate future.

New Factories for Coventry.

There are good prospects of two new factories being built in Coventry, one by the Coventry Plating and Presswork Company, Ltd., and another by a firm whose name has not yet been divulged. The first firm is negotiating for a site of approximately ten acres, and the second for some two acres. The sites are both adjacent to the railway line from Birmingham. Any extension of industrial activity will be much welcomed, and a substantial reduction in the number of unemployed in the city, now numbering 1862, should result if the factories are established.

Cannock Chase Coal Profits.

The average profit per ton on all coal raised in the Cannock Chase and Pelsall coalfield in March was 2s. 8·07d., compared with 3s. 2·76d. in February and 2s. 2·44d. in January. The owners' accumulated deficit accordingly shows a slight reduction, the present figure being £921,522, as against £933,072 a month ago. The improved conditions which have ruled during the first three months of this year are reflected in the ascertainment for the period on which the wages of miners for May are based. The ability of the owners to pay, which during April was 46·62 per cent. on the 1911 basis, has risen to 51·30 per cent. for the coming month. This means an increase in wages for stallmen of 4d. a shift, bringing their minimum wage up to 9s. 11d. per shift, compared with 9s. 7d. for the month of April and 9s. 4d.—the minimum on the 1911 basis—for the previous twenty months. Other classes of mine workers will benefit proportionately. It is doubtful whether the improvement will be maintained, for some falling off in demand for domestic supplies of coal has been apparent of recent weeks, and this tendency is likely to continue as the weather improves. The increased industrial consumption has not been sufficient to counterbalance the fall on the domestic side.

The Pipe and Tubing Cartel.

Midland pipe and tube makers have displayed considerable interest in the progress of the negotiations for establishing an international cartel for the regulation of sales and prices of gas, water and steam pipes and various classes of tubing, and now that agreement has been concluded they know exactly where they stand, at any rate until March next, and can make their plans accordingly.

Edge Tool Trade.

Staffordshire and other Midland manufacturers of heavy edge tools find business slightly less brisk than it has been of late, despite the fact that the Australasian market is at the moment buying better. Orders continue to be received from the East, South America, and South Africa, but tonnages are small. There is no slackening of competition in the industry and business is keen.

Unemployment.

The gradual decrease in the number of workless in the Midlands continues, the latest figures recording a further fall of 2824. This following, as it did, upon a decline of 7737 the previous week, makes satisfactory reading, and leads to hopes of still further reductions in the near future. The total for the area now stands at 143,752, to which Birmingham contributes 20,635 and the Stoke-on-Trent area 16,395. The only town in which an increase in the number of unemployed occurred this last week is Coventry, the town least expected to add to the total. The rise, however, is merely one of three. In the grand total the workless comprise 107,965 men, 29,117 women, 3535 boys and 3146 girls.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The East Lancashire Road.

LANCASHIRE is not without hope that the new £3,000,000 arterial road which is to be constructed through East Lancashire to connect Liverpool and Manchester will be of great commercial value. A 2-mile stretch of the road running through Liverpool to the city boundary was opened on Monday of this week by Alderman H. M. Miller, the Lord Mayor of Liverpool. From the Liverpool boundary the road will continue for a distance of about 25 miles to Irlams-o'-th'-Height, Salford. It will be 120ft. wide, embracing a central roadway of 40ft. for fast traffic, two 20ft. roads for slower transport, and two 10ft. footpaths for pedestrians. At points where the new road crosses any classified road, a circus, having a diameter of 240ft., will be formed. It is estimated that, among other materials, the work of construction will entail the use of about 500,000 tons of granite, 100,000 tons of cement, and about 3000 tons of constructional steel for bridges. The road is expected to be completed by the contractors—Sir Lindsay Parkinson and Co., Blackpool—in about four years.

Bridging the Ribble.

The General Purposes Committee of Blackpool Corporation has passed a resolution to the effect that,

having heard Mr. George Bennie's explanation of his proposed railplane bridge across the river Ribble, between Guides House and Hesketh Bank, it approves of the scheme, which should be of substantial benefit. This, of course, is merely an expression of opinion by one interested party, for there are several local authorities and other bodies which would have to be consulted, and their approval obtained, before any practical steps were taken.

Cheaper Coal.

On the question of reduced summer prices for coal, the Lancashire and Cheshire Coalowners' Association has now come into line with colliery interests in other areas. At a meeting of the Association in Manchester on Tuesday of this week it was decided to reduce the wholesale price of house coal by 1s. 8d. per ton.

Non-ferrous Metals.

Notwithstanding the fact that, on balance, the copper, tin and lead sections of the non-ferrous metals markets have, to varying extents, all lost ground compared with a week ago, the price movements in each case have not been abnormal, and, on the whole, the position at the moment may reasonably be described as more closely approaching stability than it has been for several months. In the case of copper, offers of the metal by holders outside the operations of the combine continue to exercise a restrictive influence as far as a return to higher price levels is concerned, although there has been a fair amount of business passing. Values are lower on the week to the extent of 10s. to £1 15s. a ton, according to position. Tin has been the subject of fluctuating prices at times, due to various market influences, but the net result has been a decline of roughly £4 a ton, bringing current quotations for the metal well below the £200 mark. It is anything but safe to attempt to forecast the trend of events in tin, but it is not unlikely that there will be an early recovery for the present level of prices, which is the lowest recorded for over five years. There has been only a moderate amount of buying interest shown in lead, and part of last week's advance of 10s. a ton has been lost. With regard to spelter, this has been the only section of the market to display signs of firmness, and a further advance of several shillings has to be reported.

Iron and Steel.

Although there has been little in the way of a revival of contract buying of foundry iron among local consumers, makers express themselves as well satisfied with the rate at which deliveries are being made, and it is not expected that a wave of replacement buying on a fairly important scale can be long delayed. In the meantime, there is no indication of supplies being available at cheaper rates. For delivery in the Manchester zone, Staffordshire iron is fully maintained at the fixed rate of 73s. 6d. per ton, and Derbyshire at 71s. Middlesbrough and Scottish brands are in limited request here, but prices are very firm at 81s. 6d. and 90s. per ton respectively, including delivery to users in the Manchester area. The demand for hematite iron locally is about up to its recent level, with quotations ranging from 85s. 6d. to 87s. per ton delivered. With regard to bar iron, prices are unchanged at £10 10s. per ton for Lancashire Crown quality and £10 for seconds, but the demand in this section of the market during the past week has been on a quiet scale. Owing primarily to relatively unsatisfactory conditions in constructional engineering in this part of the country, steel deliveries locally are only of moderate volume, although locomotive engineers are taking fair quantities against contracts, and small bars of special quality for bright drawing are also moving off pretty well. Except that re-rollers are inclined to modify their ideas of prices for ordinary qualities of small bars, values are firm, and show little change. Basic boiler plates are quoted here at about £9 12s. 6d. per ton, and acid qualities at 5s. per ton more, with sections at £7 17s. 6d., large bars at £8 17s. 6d., and tank plates at £8 12s. 6d. Continental mills are only doing a quiet business on this market, but there is no sign of prices coming down.

BARROW-IN-FURNESS.

Hematite.

There is a better tone in the hematite pig iron trade, and generally the demand is better. The output of eleven furnaces is evidently not sufficient to cope with the demand, for the Millom Company has put in another—the third—this week. This promises well for the future, for certainly no company is likely to go to the expense of putting in another furnace unless it is assured of a steady run. The higher price was the cause of some buyers keeping back and limiting their orders to immediate requirements, but now there is a greater tendency to place orders for forward delivery. It is some time since it was possible to give a satisfactory report of the West Coast hematite iron trade as one can do now, and it is hoped that trade will continue to be substantial, and thus give some of the companies a chance to recover from the lean times which only ended a few months ago. The demand for special qualities continues to be satisfactory, and, in fact, this business is growing. There were shipments from Barrow to Philadelphia by two of the Ford steamers during last week, and several cargoes were despatched coastwise. The iron ore trade has received a fillip by the starting of another furnace and, apart from this, there is a better demand for local ore from outside makers. The steel departments continue to produce railway material, and there are hopes that contracts will enable them to continue working. Competition is keen and orders are not very plentiful. The hoop department continues to be steadily employed on material, mostly for shipment overseas.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

CONDITIONS on the heavy side of the Sheffield steel trade show little change. There is still a full measure of activity on the basic side, the long ranges of furnaces at Templeborough and elsewhere turning out a large production. Foreign steel is now almost equal to British in price, and importations have fallen off greatly as compared with a year ago, although they are still considerable. The acid side of trade continues depressed, and several furnaces which were formerly devoted to the production of that material are now out of action. This state of things is largely due to the want of railway work. So far, British companies have placed few orders in connection with the year's programme of new construction and renewals, and the local axle, tire, and spring shops are very short of work. The city as a whole is finding some compensation for this shortage in the increasing demand for steel floors by the builders of road vehicles, but this is small consolation to the firms who have laid themselves out specially for the manufacture of railway stock, and now find themselves with plants much in excess of any probable demand. Mr. W. L. Hichens, the chairman of Cammell Laird and Co., referred at last week's annual meeting to the increasing tendency of the home railway companies to order less of their rolling stock requirements from private contractors, and to extend the manufactures of their own shops. One railway order of a substantial character, announced since my last letter, will affect some local firms and firms associated with them. It is for 400 all-steel hopper wagons, of 20 tons capacity, specially designed for iron ore traffic, and has been placed by the London, Midland and Scottish Railway Company. Cravens Railway Carriage and Wagon Company, of Sheffield, is to supply 100 of these vehicles; the Metropolitan-Cammell Carriage, Wagon and Finance Company, Birmingham—which is controlled by Sheffield companies—150; G. R. Turner, Ltd., of Langley Mill, Notts., 50; and Hurst, Nelson and Co., Ltd., of Motherwell, 100.

Good and Bad Sections.

There are signs of improvement in several departments of local industry, and during the past week a fair number of unemployed men have been absorbed at the works. At the same time, there are many evidences of slackness to be found in the city, on both the heavy and light sides, and, for the time of the year, the general position is not satisfactory. While there has been some increase in the number of orders, many of them are on a very small scale, and their execution leaves little or no profit. The automobile industry is still making large demands on Sheffield, and the trade in steel and tools to meet its requirements is of important dimensions. There is also a good demand for steel castings and forgings, mining drill steel and cold-worked steel. At the rolling mills, much quietness is reported. Twist drills and cutters of all qualities are enjoying a fair demand, and this branch of trade occupies a stronger position than it has done in past years. The factories making edge and joiners' tools would welcome more work. A good sale is being experienced for farm tools, but for garden tools the inquiry is poor, and the prospects of the season are not good.

£100,000 Worth of Magnet Steel.

An important order for magnet steel has been received by Darwins, Ltd., Sheffield, the steel and safety razor firm, which has recently emerged with great success from a period of liquidation, and which is to pay off all its creditors with interest. The order is for magnet steel, of the value of £100,000, for Philips Radio, Kindhaven, Holland, one of the biggest manufacturers of electric light globes on the Continent. From the middle of May onwards, 55,000 magnets per week will be sent from Sheffield to fill this large order. Mr. G. C. Hans Hamilton, the new chairman of the company, states that, in spite of tariffs, they are now selling magnet and other steels to France, Germany and the United States in substantial quantities. The public company of Darwins has been registered, with a capital of £730,000 in £1 shares, 30,000 of the shares being ordinary and the rest 7½ per cent. cumulative preference.

Furnace for South Africa.

The South African Government has placed another order with Vernon Cutts and Co., Ltd., of Sheffield, for an electric furnace, which will be considerably larger than anything previously installed in that country. The company has installed several furnaces in the Transvaal during the last two or three years, but this will be its first in Natal.

Cutlery and Plate.

Conditions in the cutlery trade vary, but in the majority of cases firms are very short of work, only a few being able to report a good state of employment. The severity of competition leads to a good deal of price cutting. For the hafting of table knives of the better qualities, the new non-inflammable materials, which are to some extent displacing celluloid, are being used to an increasing extent. Sheffield safety razor blades continue to sell very well in both home and export markets, including the United States, to which large quantities of blades and blanks are being sent. The demand for electro-plate from the general public, which has been declining for a long period, is still shrinking, and travellers' reports from London and the provinces are disappointing. A number of valuable special contracts for the equipment of steamships and restaurants continues to come forward.

Too Many Shipbuilders.

Although the chairman of Cammell Laird and Co. was able to inform the shareholders at last week's meeting that the firm's Birkenhead shipyard launched its record tonnage in 1928, he could not speak with satisfaction of the position of the shipbuilding industry. He said prices were more keenly cut than ever last year. The plain fact was that there were too many shipbuilding firms in existence, and there was no reasonable ground for hoping that they would all be fully employed in the near future, or indeed ever. Consequently, there was a scramble for whatever work was going, and prices were cut to the bone. He did not regard this state of affairs as satisfactory, for prices were below the economic level, and the shipbuilding industry as a whole was bound to suffer from it. He believed that the problem could best be solved by collective action on the part of shipbuilders, but they did not at present appear to be disposed to take the necessary steps. "We are groping in the twilight," Mr. Hichens concluded; "but perhaps when it is dark enough we shall see the stars."

Grimsby and Goole Docks.

There has been some hitch in the financial arrangements in connection with the proposed construction of a new dock at Grimsby, but it has been overcome. The dock is to be built by the Corporation and leased by the L.N.E.R. Company, which is to pay for it in thirty years and take possession of it. The Corporation is seeking parliamentary powers to borrow £1,250,000 for the purpose of the work. It was at first arranged that the railway company should give the Corporation, as security, a first charge on its profits, ranking before debenture holders. It now appears, however, that there are legal difficulties in the way of giving this priority, and the Corporation has agreed to accept instead £1,250,000 5 per cent. debenture stock, to be created by the company, as collateral security. At Goole, there is a demand for the improvement and extension of dock facilities, and the Chamber of Commerce and Shipping has resolved to communicate with the Aire and Calder Navigation and the L.M.S. Railway Company on the matter. The Goole steamship manager for the L.M.S. stated at the meeting of the Chamber that the railway company had a scheme complete in all details for the utilisation of the north side of the new West Dock, but that there was some question of justification for the spending of the money. A little support from the Chamber might help to hasten matters.

NORTH OF ENGLAND.

(From our own Correspondent.)

Healthy Trade Position.

THERE is a healthy tone about all branches of industry in the North of England, particularly in the iron and steel trades. The fact seems to be that British producers are regaining their competitive power in the world's markets, and one of the brightest features of the past month's trading has been the heavy shipments overseas and the further big business booked. The exports of pig iron from the Tees during April were the heaviest for three years. To South America steel shipments were on a considerably increased scale, and cargoes of both pig iron and steel were dispatched to Canada. Aggregate tonnage output of iron and steel in this area is heavy, but will have to be increased to meet the steady growth of demand. Home customers are understood to have further substantial orders to distribute, and expansion of export trade is expected. Prices of many continental products are about the same as those named for the manufactures of this area; hence lost markets are gradually being regained. Producers in the North of England are well sold, and are in no hurry to enter into further contracts at present recognised rates, but they agree that a substantial advance in quotations might check the demand, so that the rise in prices, if it comes, is likely to be gradual. Although there is a lull just now in shipbuilding inquiries and orders, the industry is in a much more active state than it was a year ago, and work in hand at many of the yards assures brisk employment into the early months of next year. The engineering trades are improving, and active conditions still prevail in the coal trade.

Cleveland Iron Trade.

The continued scarcity of Cleveland pig iron is causing anxiety and inconvenience. There are virtually no saleable stocks. Makers have disposed of their output well ahead and the promised enlargement of output is altogether insufficient to afford material relief to the stringent situation. Home demand is expected to continue heavy for some time, and a fair amount of export business might now be put through, if iron were available. Ironmasters are unable in some cases to give full delivery against running contracts. Purchases of Cleveland iron cannot be made from ironmasters for supply before August, and only small parcels can be obtained from second hands for early delivery. Forward quotations are as follows:—No. 1 foundry iron, 71s.; No. 3 G.M.B., 68s. 6d.; No. 4 foundry, 67s. 6d.; and No. 4 forge, 67s.

Heavy Exports of Iron and Steel.

The return of exports of pig iron, manufactured iron, and steel from the Cleveland district during April reveal a bright state of affairs. Not for three years have deliveries of pig iron to Scotland been so heavy; it is over three years since a month's shipment of pig iron to the Tees exceeded 30,000 tons, as they did last month, and it is necessary to go back exactly two years to find a parallel to the shipment of 96,912 tons of pig iron, manufactured iron and steel from the Tees in the space of a calendar month. Cleveland iron is finding its way into markets which have been closed for months and even years past. The fact that 4095 tons of iron were shipped across the Atlantic last month suggests that there may be a market there capable of considerable expansion. In the steel trade there is evidence of a growing export demand, the April shipments totalling 66,811 tons, as compared with 54,334 tons in March. The principal buyers were India and Ceylon, 15,303 tons; South and East Africa, 14,130 tons; South America, 6920 tons

Hematite Pig Iron.

Both home and continental demand for East Coast hematite pig iron is more than manufacturers can meet. Merchants are fairly well bought, but expect prices to rise, and are not disposed to undersell makers to any extent. For June supply and onward, consumers are readily paying 74s. and upward for hematite, according to the quality of the iron.

Ironmaking Materials.

Foreign ore merchants are unshaken in their firm attitude by the absence of buyers from the market.

Supply threatens to be somewhat short, as heavy deliveries to continental consumers are falling due. Market rates are on the level of best Rubio ore at fully 23s. c.i.f. Tees. Durham blast-furnace coke is not so scarce as it has been, and values are easier, but the prevailing opinion is that little further increase of marketable parcels is likely. Good medium kinds keep at 19s., delivered at the works.

Manufactured Iron and Steel.

Most descriptions of manufactured iron are selling well, and prices are steadily upheld. Semi-finished steel producers are very busy, and report that customers are still coming forward freely. There is also a strong home and overseas demand for finished steel. Prices, although unchanged, show a marked upward tendency.

The Coal Trade.

The Northern coal trade position is not maintaining the recent firmness, and only in sections is there any cheerfulness to note. Under recent cutting of prices from Poland, buyers are holding off the local market, and any business offers, except for early shipments, are at low prices and not tempting. There is considerable variation, however, in individual positions. Some fitters have cleared off all their May output, and are able to quote stiff prices for any odd lot that turns up from day to day. Others, however, have large stocks to clear, and have to face a slow market. The labour situation in the Ruhr is attracting attention. If the strike attitude develops, it is certain to have a hardening effect on values in this market. The prospects, apart from the possibilities in the German mining situation, are fairly good for most classes of fuel. The Genoa Gasworks order for 20,000 tons of gas coals has come to this district in face of fierce foreign competition, but the price has not been divulged. The figure is probably in the region of 25s. 6d. c.i.f. In some previous similar contracts freights went against the exporter, but the price on this occasion is probably more in harmony with current freights and coal values. Inquiries from abroad are quiet just now, but there is business in abeyance, and buyers will doubtless come on to the market again as May advances. Foreign competition may continue acute, but as a set-off against this, there is the world's growing demand for coal. There is fully sustained strength in the Durham coal market. It is the best feature at present. Durham steams are in strong demand, and scarce for any part of May shipment at 18s. 6d. Gas and coking coals continue in good general demand, and operators express confidence that there will be no setback at least for the month of May. Best qualities of gas coal are quoted at from 15s. 9d. to 16s. 6d. Secondaries are in better supply at 15s. to 15s. 6d. Coking prices remain firm at 15s. 6d. to 16s., and the bunker trade is fairly active and steady in tone. Northumberland steam coals generally are plentifully offered, and under reserve of buyers the undertone is easier. Supplies of best steams are offered freely through contractors at substantial concessions on the nominal quoted prices of 15s. to 15s. 6d. There is no special movement in the coke trade. Present output is ample to meet all demands, and stocks are slowly increasing. Gas coke direct is quoted steadily at 19s., but second-hand holders press on the market at discount prices. Patent oven cokes are also plentiful and easy in tone at 18s. to 18s. 6d. Beehive and special foundry kinds are quoted freely at unchanged prices, 24s. to 28s. 6d., according to descriptions.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

The rate of output from Clyde yards during April continued on a high level, twenty-two vessels of 44,423 tons aggregate being launched. This is the highest total for the month since the year 1925. The total output for this year to date just exceeds the returns for the same period last year. Of the vessels launched last month one was just over 9000 tons, four between 5000 and 6000 tons, and one of 4000 tons. Though the work under construction has increased since the beginning of the year, the total is less than it was twelve months ago, and with a continuance of the present rate of output, there will be in all probability an increasing amount of unemployment unless there is an increase in the number of new contracts placed. During last month the folllowing contracts were reported: —One for eighteen steamers on behalf of the Cia de Nav. Lloyd Brasileiro, of Rio de Janeiro, and entailing an expenditure of about £2,000,000, the order to be allocated between Scott's Shipbuilding and Engineering Company, Greenock, and the Burntisland Shipbuilding Company. Scott's, of Greenock, are also to build four cargo steamers of 8000 tons each for London owners; a 12,000-ton twin-screw motor ship for Bibby, Brothers and Co., Ltd., is to be built at Fairfield.

Steel.

The position as regards heavy steel has undergone little change. Conditions remain comparatively quiet, and some producers find difficulty in maintaining their present rate of output. Sections are in fairly good demand, but plates are rather quiet. It is hoped, however, that the shipbuilding contracts mentioned above may be the forerunners of others, which may bring much-needed orders to steel makers. Steel sheetmakers experience an unusually quiet period. Competition is keen, and business has fallen far short of the usual spring time demand. The higher costs of raw materials is also a disturbing factor, makers finding great difficulty in securing prices commensurate with increased costs.

Iron.

The bar iron industry remains quiet. Though an advance in prices would be quite in order owing to the increases in raw materials, the Scottish makers retain fixed home prices at the old level even although English producers have increased their quotations. In the re-rolling department business has gone off somewhat, but here again prices are maintained at recent levels of £8 home and £7 15s. export owing to higher costs. Of late there has been a better demand for tube strips.

Pig Iron.

Business in pig iron is not by any means brisk. Hematite has been a shade busier just recently, but foundry pig iron has had rather a lean time. Minimum prices were raised recently, but producers consider that even yet the level of quotations is not high enough to be remunerative.

Tubes.

Tube makers report continued activity in practically all branches. A feature has been the recent increase in demand for iron boiler tubes.

Coal.

The general situation in the Scottish coal trade has not improved during the past week. Shipping demands have increased a little, but nothing of any great importance has been booked, and prices are still more or less a matter of arrangement. The collieries are taking a stand against further price cutting, and will in all probability again resort to a curtailment of output. Home demands, too, are falling away in view of the longer days. Industrial requirements are still fairly heavy, but utility concerns are now taking smaller deliveries, and household demands are shrinking. Aggregate shipments amounted to 228,024 tons, against 229,117 tons in the preceding week and 239,544 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

There has not been a great deal of alteration in the general conditions prevailing in the steam coal trade during the past week, though it must be conceded that there is rather more irregularity in the market, so far as the lower grades of coals are concerned; but taking the market as a whole, it is a good deal steadier than many buyers expected it to be by this time. The view was held in many quarters that the market was in for a very severe setback, but there is no doubt that this view has had to undergo modification, for the reason that it has been discovered that practically the whole of the Admiralty quality coals are fairly well off for prompt loading, and salesmen are not relaxing their prices for early shipment, though, of course, they may show a disposition to make concessions for later positions. At the same time it is recognised that the month of May will be a short working month, owing to the Whitsuntide holidays, and this being the case the probabilities are that this will check the tendency of the market to fall way to a very material extent. It has also been somewhat of a surprise that the tonnage supplies should be so good, inasmuch as the number of waiting steamers has very closely approximated to the number of berths vacant. The returns of tonnage chartered recently have been slightly better, but at the same time the quantity is far below what is required to infuse strength into the coal market, which goes to show that there must be a good deal of business arranged which does not come on to the market, and which makes it rather difficult for those who are outside the big combines really to gauge the strength of the position. Cargo shipments last week were not quite up to the level of the preceding week, as the total was just over 478,564 tons, as against rather more than 502,564 tons. So far as can be seen, the foreign demand does not appreciably expand, but the belief is held that the inquiry will before long display some expansion, especially when it is realised that prices are not likely to fall away to any great extent. So far no news is to hand of any extensive contract business being placed, except that it is now reported that the Egyptian State Railways have placed their requirements of 180,000 metric tons of locomotive coals for delivery from May to August at Alexandria. It is understood that the tender of Tabb and Burleteon for 60,000 tons at 29s. 6d., and those of Pyman, Watson and Co., Ltd., and of William Milburn and Co., of 60,000 tons each, at 29s. 9d.—all c.i.f. Alexandria—have been accepted.

Irish Coal Trade.

South Wales colliery representatives met at Cardiff on Monday when the question was discussed of fixing a schedule of minimum prices for coal exported to Ireland. There was no official news forthcoming regarding the proceedings, but it is reported that the Coal Marketing Association proposes to establish a minimum schedule, closely approximating to current market prices. It appears that negotiations have been in progress for some time respecting national co-ordination in the matter of supply of coals to Ireland, and the scheme, which it is hoped to bring into operation, involves not only co-operation on the part of coalowners throughout this country, but on that of the Irish importers as well. The idea is that there should be a joint Co-ordinating Committee representative of both the Irish Importers' Association and the associations of coalowners in this country, and that this body should meet periodically to consider all matters in connection with the supply of coals to Ireland, including the raising or lowering of prices from time to time. It is stated that the Irish Importers' Association is representative of merchants responsible for over 95 per cent. of the total import trade of Ireland.

G.W.R. Returns of Trade.

The returns of the Great Western Railway Company of seaborne traffic at the ports under its control in this district are not quite as satisfactory for the four weeks ended April 14th as those for the preceding month, though regard must be paid to the fact that the holidays at Easter are partly responsible for the diminution. The total imports and exports for the period in question came to 2,783,045 tons, made up of 321,754 tons of imports and 2,461,291 of exports, which compare with an aggregate for the four weeks ended March 17th last of 3,136,935 tons, made up of 416,040 tons of imports and 2,720,895 tons of exports. So far as coal and coke shipments were concerned, the total was 2,183,624 tons, as against 2,441,824 tons. Taking the whole of this year to April 14th, the whole trade comes to 10,610,273 tons, which compares with 10,032,245 tons in 1928, so that the balance is on the right side.

Current Business.

New business continues rather on the quiet side, but the position of most collieries producing the superior grades of large coals is fairly good for prompt loading. Admiralty large and best Monmouthshires maintain steadiness, and dry qualities display little alteration, while washed coals are not over-plentiful, but smalls are relatively in better supply and somewhat on the easy side. Best Admiralty large coals are round about 21s., and best smalls round about 14s. There is no improvement in patent fuel, but coke supplies are readily absorbed. Pitwood is weak at about 26s. 3d. to 26s. 6d.

CONTRACTS.

The Hydraulic Engineering Company, Ltd., of Chester, has received from the Great Western Railway an order for two movable coal hoists and traversers for Alexandra Dock, Cardiff.

Ferguson Brothers (Port-Glasgow), Ltd., Newark Works, Port-Glasgow, have received an order from the Alexandra Towing Company, Ltd., Liverpool, for a powerful passenger tender, the vessel to have twin screw engines and two boilers with Howden's forced draught.

The Electric Furnace Company, Ltd., has recently received orders for (*a*) two Héroult furnaces for India and Brazil respectively; and (*b*) four Ajax-Wyatt furnaces, each of 600 lb. capacity, and four Ajax-Northrup high-frequency furnaces varying from 15 cwt. to 2 cwt. capacity, for France. The same company will also shortly be putting into operation in France (*c*) a 1-ton Ajax-Northrup furnace, designed and built in Great Britain, which is claimed to have an output equivalent to that of a 4-ton arc furnace or an 8-ton open-hearth furnace, and to be the largest high-frequency furnace yet constructed in Great Britain; (*d*) three 5-cwt. Ajax-Northrup furnaces in France, which were ordered last year.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Blackstone and Co., Ltd., of Stamford, ask us to announce that they have opened a branch at Groat House, Collingwood-street, Newcastle-on-Tyne.

Mr. J. W. Thomas, LL.B., B.Sc., A.M.I.E.E., who has held the position of Assistant General Secretary of the Electrical Power Engineers' Association for the past nine years, has now resigned.

We understand that a new company has now been registered under the title of Parker Foundry (1929), Ltd., Derby, to take over the old-established business of the Parker Foundry Company, Ltd. The managing director of the new company is Mr. T. McLean.

Sir W. G. Armstrong, Whitworth and Co., Ltd., ask us to announce that the address of their office has been changed from Kinnaird House, Pall Mall East, S.W. 1, to Park House, 22–26, Great Smith-street, Westminster, S.W. 1. Telephone, Victoria 2233; telegrams, "Zigzag, Parl, London."

The Flexible Drive and Tool Company asks us to announce that it has moved its offices and showrooms from 35, Bloomsbury-square, to 3, Bloomsbury-place, Bloomsbury-square, London, W.C. 1, to which address it requests that, in future, all communications should be sent. New telephone number, Museum 7458.

CATALOGUES.

T. V. E., Ltd., 25, Victoria-street, S.W. 1.—Illustrated price list of "Tovoo" triplex blade fans.

Daniel Adamson and Co., Ltd., Dukinfield.—Particulars of the D. and A. patented system of drainage.

Premier Electric Welding Company, Ltd., Abbey Wood, S.E. 2.—Particulars of "Bellfinish" electrodes.

Petters, Ltd., Yeovil.—Publication No. 1713 containing full details of Petter S. and N.S. type marine oil engines.

Herbert Morris, Ltd., Loughborough.—Book 182 illustrating electric telphers at work in various parts of the world.

Alley and MacLellan, Ltd., Sentinel Valve Works, Worcester.—Catalogue W.6 of "Sentinel" patented steam traps.

Pressure Piling Company, Ltd., 119, Victoria-street, S.W. 1.—A detailed description of the firm's system of pressure piling.

Donovan and Co., 47, Cornwall-street, Birmingham.—A pamphlet describing a new type of isolating link for use in factories.

George Cohen, Sons and Co., Ltd., 600, Commercial-road East, E. 14.—Catalogue of the firm's stock of machine tools of all classes.

James Hendry, Ltd., 252, Main-street, Bridgeton, Glasgow.—Booklet dealing in detail with the firm's laminated leather endless belting.

F. Braby and Co., Ltd., Petershill-road, Glasgow.—A brochure on dovetail steel sheeting for floors, walls, roofs, partitions, &c.

Drayton Regulator and Instrument Company, Ltd., West Drayton, Middlesex.—Particulars of the "Thermogas" temperature; also a booklet containing details of "Drayton" steam traps for all purposes.

Ex-Siemens' Men.—At a meeting held at the Hotel Cecil on April 27th, it was decided to form the Association of Ex-Siemens' Men, and some of the Committee and the officers were elected. The qualification for membership is that applicants shall be ex-members of the Siemens' organisations and shall have served at least one year on the staff of such organisations. A re-union dinner will be held at the Hotel Cecil on Wednesday, May 29th next. Mr. J. Snow Huddleston, M.I.E.E., The Union Cable Company, Ltd., Dagenham Dock, Essex, has been appointed hon. secretary and treasurer, and will be pleased to forward full particulars of the Association and also of the dinner re-union to any intending members.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/6 to 21/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 18 0	—
No. 1 Foundry	3 15 0	—
No. 3 Foundry	3 12 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 14 0	3 14 0
No. 1	3 14 6	3 14 6
Cleveland—		
No. 1	3 11 0	3 11 0
Silicious Iron	3 11 0	3 11 0
No. 3 G.M.B.	3 8 6	3 8 6
No. 4 Foundry	3 7 6	3 7 6
No. 4 Forge	3 7 0	3 7 0
Mottled	3 6 6	3 6 6
White	3 6 6	3 6 6
MIDLANDS—		
(3) Staffs.—	(*Delivered to Station*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 11 0	—
„ „ Foundry	3 13 6	—
(3) Northampton—		
Foundry No. 3	3 9 0	—
Forge	3 5 0	—
(1) Derbyshire—		
No. 3 Foundry	3 12 6	—
Forge	3 8 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 6 0	—
No. 4 Forge	3 0 0	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 4 6 (a) / 4 7 6 (b) / 4 11 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 10 0	—
Second Quality Bars	10 0 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 15 0 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 12 6 to 8 17 6	—
Gas Tube Strip	10 17 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 15 0	8 12 6
Sheets (Gal. Cor. 24 B.G.)	13 10 0	13 12 6 to 13 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0	—
Light Rails	8 5 0 to 8 10 0	—
Billets	6 15 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	8 17 6	—
„ (Small Round)	8 10 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6 to 8 17 6	—
„ (Lancs. Boiler)	9 12 6 to 9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	8 15 0 to 9 0 0	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	7 0 0	—
Hoops	9 10 0	—
Soft Wire Rods	7 12 6	—
MIDLANDS—		
Small Rolled Bars	8 5 0 to 8 15 0	—
Billets and Sheet Bars	6 7 6 to 6 12 6	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 7 6 to 13 10 0	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	9 15 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/4½ to 18/9
Block Tin (cash)	198 0 0
„ „ (three months)	200 10 0
Copper (cash)	77 5 0
„ (three months)	73 0 0
Spanish Lead (cash)	24 10 0
„ „ (three months)	24 0 0
Spelter (cash)	26 15 0
„ (three months)	26 15 0
MANCHESTER—	
Copper, Best Selected Ingots	80 10 0
„ Electrolytic	84 5 0
„ Strong Sheets	112 0 0
„ Tubes (Basis Price), lb.	0 1 3½
Brass Tubes (Basis Price), lb.	0 1 1½
„ Condenser, lb.	0 1 3½
Lead, English	26 5 0
„ Foreign	24 12 6
Spelter	26 17 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

Tungsten Metal Powder	3/- per lb.	
Ferro Tungsten	2/10 per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 0 0	7/6
„ „ 6 p.c. to 8 p.c.	£24 0 0	7/-
„ „ 8 p.c. to 10 p.c.	£23 10 0	6/-
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£38 0 0	12/-
„ „ „ 1 p.c. carbon	£40 0 0	15/-
„ „ „ 0·70 p.c. carbon	£45 0 0	17/-
„ „ „ carbon free	1/2 per lb.	
Metallic Chromium	2/6 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home	
	£13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
„ „ 75 p.c.	£19 10 0 scale 6/- per unit	
„ Vanadium	13/6 per lb.	
„ Molybdenum	3/9 per lb.	
„ Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/6
„ „ Ell	15/-
„ „ Splint	16/- to 16/6
„ „ Trebles	13/6
„ „ Doubles	12/9
„ „ Singles	11/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/6
„ „ Jewel	17/6
„ „ Trebles	13/6
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	12/- to 13/6
Screened Navigation	17/6
Trebles	13/6 to 14/-
Doubles	12/6
Singles	11/9
LOTHIANS—	
(f.o.b. Leith)—Best Steam	13/-
Secondary Steam	13/-
Trebles	13/6
Doubles	12/6
Singles	11/6

ENGLAND.

(8) N.W. COAST—	
Steams	25/-
Household	38/- to 51/-
Coke	23/6 to 24/-
NORTHUMBERLAND—	
Best Steams	15/- to 15/3
Second Steams	14/- to 14/3
Steam Smalls	9/6 to 10/6
Unscreened	13,9 to 14/-
Household	21/- to 27/-
DURHAM—	
Best Gas	15/6
Second	15/- to 15/3
Household	21/- to 27/-
Foundry Coke	22/6 to 25/-

SHEFFIELD—	Inland.	
Best Hand-picked Branch	27/- to 28/6	—
Derbyshire Best Bright House	20/- to 23/-	—
Best House Coal	19/6 to 20/6	—
Screened House Coal	17/6 to 18/6	—
„ „ Nuts	16/- to 17/6	—
Yorkshire Hards	15/6 to 16/6	—
Derbyshire Hards	15/6 to 16/6	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	6/- to 7/-	—
Smalls	2/6 to 4/-	—
Blast-furnace Coke (Inland)	14/6 at ovens	—
Furnace and Foundry Coke (Export), f.o.b.		20/-

CARDIFF— (9) SOUTH WALES.

Steam Coals :	
Best Smokeless Large	20/9 to 21/3
Second Smokeless Large	20/6 to 20/9
Best Dry Large	20/6 to 21/-
Ordinary Dry Large	19/6 to 20/-
Best Black Vein Large	20/3 to 20/6
Western Valley Large	20/- to 20/3
Best Eastern Valley Large	19/6 to 20/-
Ordinary Eastern Valley Large	19/- to 19/6
Best Steam Smalls	14/- to 14/3
Ordinary Smalls	12/6 to 14/-
Washed Nuts	20/- to 24/-
No. 3 Rhondda Large	21/- to 21/6
„ „ Smalls	15/- to 15/6
No. 2 „ Large	18/- to 18/6
„ „ Through	16/6 to 17/6
„ „ Smalls	13/- to 13/6
Foundry Coke (export)	26/6 to 36/-
Furnace Coke (export)	19/- to 21/-
Patent Fuel	20/6 to 21/6
Pitwood (ex ship)	26/- to 26/6
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	33/- to 35/-
Seconds	27/6 to 30/-
Red Vein	24/- to 27/-
Machine-made Cobbles	40/- to 43/6
Nuts	40/- to 44/-
Beans	23/6 to 25/6
Peas	17/- to 18/-
Breaker Duff	9/6 to 10/-
Rubbly Culm	9/6 to 10/-
Steam Coals :	
Large	18/- to 19/-
Seconds	17/- to 18/-
Smalls	10/6 to 13/-
Cargo Through	15/9 to 16/9

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

The Trade Balance.

FOR several months past the "balance of trade" has been growing more and more unfavourable, but little attention has been paid to it because it affected in no way the general situation, which has become remarkably strong in view of the abundance of employment in all branches of industry, and since activity is now so general that manufacturers are unable to accept all the work that is offered them. Hence, the steadily increasing adverse balance of trade failed to disturb the equanimity of makers until the returns for the first quarter of the year were published. Then it became evident that the situation was abnormal and might indeed, later on, have serious consequences for the engineering and other trades. The values of imports during the first three months were estimated at 15,269 million francs, an increase of 2314 million francs, as compared with the corresponding period of 1928. The exports were valued at 12,000 million francs, a decline of 761 million francs. The imports, therefore, exceeded the exports by 3269 million francs. About one-half of the increase in imports was due to raw material. The exports declined all round, and the values of "material necessary for industry" and manufactured goods contracted by 588 million francs. A notable feature was the considerable diminution in the value of manufactured goods exported. It is therefore quite clear that the present industrial activity is due almost entirely to the carrying out of public and other works at home, and that, too, may, partly, be the cause of the increase of a million tons in the imports of coal, although the exceptionally severe weather must also have stimulated the fuel imports. Much of the manufactured goods came from Germany, which has enormously increased its consignments of machinery to this country since the putting into operation of the Franco-German commercial arrangement. The fact that chiefly concerns French manufacturers is that the activity at home is causing them to lose their hold on foreign markets, and the difficulty in procuring skilled labour is increasing to an extent that threatens to aggravate seriously the problem of rising manufacturing costs. If, therefore, anything should happen to interfere with the carrying out of public works, the situation is likely to become very unsatisfactory. So long, however, as France is able to depend upon German reparations there is some prospect of the activity continuing for a considerable time.

The Steel Cartel.

There have been persistent rumours that German steelmakers were on the point of withdrawing from the Steel Cartel. As they did not notify their intention of doing so before the statutory date, it is not supposed that they will carry out their threats, especially now that they have partial satisfaction over some of their claims, and even if they do, it is believed that they will withdraw merely in order to reconstitute the Cartel on a new basis. Their object is mainly to organise the Cartel in association with an international sales bureau, and they will certainly not wreck an organisation that saved the continental steel industry from collapse and has given to it a permanent stability. Practically all branches of the iron and steel industry are now grouped into unions for an adjustment of production and prices, and it is hoped eventually to develop the organisation and extend its operations so as to give to it a really international character.

West African Railways.

The extraordinary difficulties that have been encountered in the building of the Brazzaville-Pointe Noire Railway in French Equatorial Africa, particularly the heavy death roll of native porters, have shown the necessity of changing the methods of construction. Instead of carrying material from the Port of Pointe Noire by natives through extremely difficult and unhealthy country, the transport is to be effected by way of the Belgian Congo. The Matadi-Leopoldville Railway already has great difficulty in dealing with the heavy traffic in the Belgian Colony; but nevertheless arrangements have been made to carry a considerable quantity of material for the French railway, and it is proposed to install a ferry boat at Stanley Pool in order to connect up Leopoldville with Brazzaville. At the same time, the Governor of French Equatorial Africa has promulgated a series of regulations for the protection of native labour, whereby an eight hours' working day, with a minimum wage, is enforced, and other measures are to be taken for the well-being of the natives. This is preliminary to the execution of the programme of public works, which had been delayed, not only by financial difficulties, but also by a lack of experience in the proper handling of native labour.

The Cruiser "Foch."

The cruiser "Foch," which has been launched at Brest, is the fifth of the series of 10,000-ton cruisers being built under the programme of naval construction. She has the same dimensions as her predecessors, that is to say, the length is 185 m. and the width 19·2 m., and she draws 6·3 m. of water. She will have three groups of geared turbines developing 90,000 horse-power. The cruiser is expected to steam at a speed of close upon 33 knots. Steam will be supplied by six boilers that may be fired either with coal or oil, and an auxiliary boiler which will be exclusively oil fired. The armament will consist of eight 203 mm. guns in four axial double turrets, sixteen anti-aircraft guns, six torpedo tubes and two seaplanes to be launched by a catapult. The "Foch" is very thoroughly subdivided into watertight compartments, and the only difference from the "Duquesne" and the "Tourville" is that the engines and boilers are protected by a light belt. This is a concession to the criticisms that have been made upon the vulnerability of the cruisers in which armour is entirely sacrificed to speed. The "Foch" was on the stocks exactly ten months.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

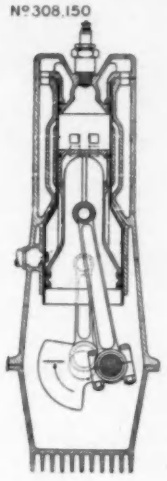
When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

Nº 308,150



308,150. September 5th, 1928. —TWO-STROKE ENGINES, J. W. Robertson, Hollybush, Drymen, Stirlingshire.

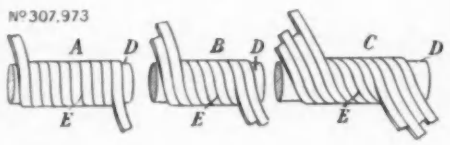
The inventor claims that in his two-stroke engine the loss of unburned mixture through the exhaust ports is minimised. He employs an annular trunk piston for the compression of the charge, and a sleeve valve to control the transfer and exhaust of the gases. After exhaust has taken place, he admits a small amount of low-pressure mixture to scavenge the cylinder. Then the transfer passages are closed at the top, and the rest of the charge is compressed in them to a high-pressure. Finally, this highly compressed charge is admitted to the cylinder at the top of the stroke. The sleeve valve, it will be seen, lags behind the piston.—*March 21st*, 1929.

TELEGRAPHS AND TELEPHONES.

307,973. December 16th, 1927.—IMPROVEMENTS IN OR RELATING TO LOADED ELECTRICAL CONDUCTORS, Willoughby Statham Smith, of Benchams, Newton Poppleford, Devonshire; Henry Charles Channon, of 4, Fitzgeorge-avenue, Kensington, London, W. 14; Arthur Lennox Meyers, of 52, Temple-road, Croydon; and Norman George Robert Partridge, of 13, Navarino-road, Dalston, London, E. 8.

According to this invention the relative angle of lay between a conductor and a loading tape or wire associated with it, is varied over the length of the conductor, whereby the field strength in the loading material is made to approximate closely to its most advantageous value over the length of the conductor. The invention is illustrated in the accompanying schematic drawings. These drawings are not intended to show actual angles of lay

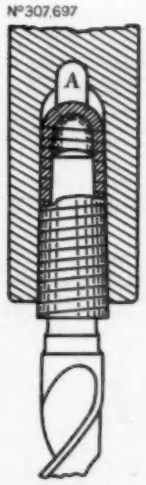
Nº 307,973



or relative sizes of loading and conductor, but are merely illustrative of the invention. The actual angles of lay and relative sizes of loading and conductor in any case will be calculated and determined in the usual way. The drawings show the invention applied to a loaded cable of the kind in which the loading material is wrapped about a conductor; the cable comprises sections A, B, C, but only three sections are shown, the relative lay between conductor D and loading E being varied between the sections. The spaces between turns of loading material, owing to increased pitch consequent upon an increased angle of lay, are filled in by additional tapes of loading material. In general the weight of loading material per unit length of the conductor will be maintained constant, though, if desired, it may be varied.—*March 18th*, 1929.

MACHINE TOOLS AND SHOP APPLIANCES.

Nº 307,697



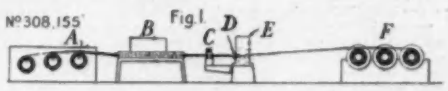
307,697. October 30th, 1928.—DRILL SOCKETS, A. Schoenwerk, 16, Neue Königstrasse, Berlin, N.O. 43, Germany.

This drill socket is formed of a tightly coiled helix of square section steel wire. The closed end is formed by welding together the last few turns and forming them in a die, so as to provide an abutment for driving out the socket with a wedge A. It is claimed that when the drill encounters resistance the socket slightly expands, so that it fits the bore of the drilling spindle still more closely and at the same time the shank of the drill enters deeper into the socket and is gripped by it more tightly. After use the drill may easily be withdrawn from the socket by hand.—*March 14th*, 1929.

308,155. October 4th, 1928.—GUIDE APPARATUS FOR STRIP ROLLING MILLS, *L. Mellersh-Jackson, 28, Southampton-buildings, Chancery-lane, London, W.C. 2.*

This apparatus is intended to insure that, in the pack rolling of cold rolled strip, the strips shall lie properly one above the other, so that their edges all coincide. In Fig. 1 the feed reels are shown at A. B is a device for wiping oil off the strips. C is a tension device to keep the strips taut. D is a guide, E the rolls, and F the reels for the finished strips. On reference to Fig. 2 it will be seen that the guide is so formed that it can go close up between the rolls. Plates G are arranged to separate

Nº 308,155 Fig. 1.



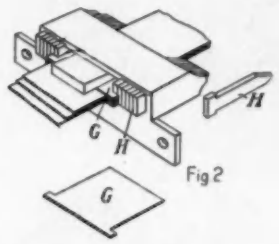


Fig. 2

the strips, and the strips are guided transversely by the blocks H. These blocks are made in sections so that different widths of strip can be accommodated.—*March 21st*, 1929.

MISCELLANEOUS.

278,751. October 8th, 1927.—ELECTRONIC DISCHARGE DEVICES, *Manhattan Electrical Supply Company, Inc., of 17, Park-place, New York City, U.S.A.*

The rectifier described in this specification is placed within a glass envelope filled with neon at a pressure of 2 mm. or 3 mm. of mercury and comprises a carbon electrode A and a hollow hemispherical aluminium electrode B. The carbon electrode A is fitted within a cavity C provided near the upper end of a cylinder D which may be composed of lava, porcelain, or other suitable insulating material, and it is longitudinally perforated at E. An aluminium rod fastened at one end into base F of the carbon electrode and at the other end to a leading-in wire G passes through the perforation E, which is enlarged at the lower end of the cylinder D, as indicated at H, and accommodates a glass stem K which surrounds the rod and the leading-in wire G. The base F of the carbon electrode substantially fills the cavity C

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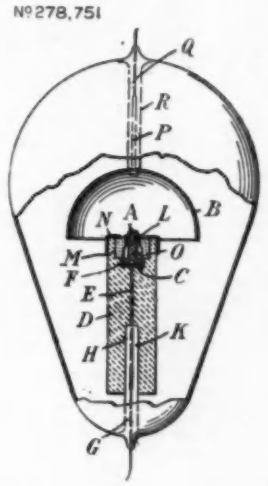

of the cylinder and is held therein by means of a ring L fitted in an enlarged cavity M in the upper end of the cylinder D. The ring L is of insulating material, such as lava or porcelain, or may be of metal if properly insulated from the carbon, and is held in place by means of a ferrule N. The carbon electrode A projects through the ring L above the ferrule N. The ring L is undercut at its base, increasing its spacing from the carbon, as indicated at O. The aluminium electrode is fastened to an aluminium rod P, which, together with its leading-in wire Q, is protected by a glass stem R. The edge of the aluminium electrode extends to a point slightly below the upper end of the cylinder D. It has been found that a rectifier constructed in accordance with the invention is capable of converting alternating current at very high pressure into direct current at correspondingly high pressure, and operates successfully for 4000 hours or more.—*March 8th*, 1929.

307,688. August 10th, 1928.—A MEANS FOR PRODUCING HOLLOW ARTICLES, F. Im Schlaa, 12a, Gerlingsweg, Iserlohn, Westphalia.

The claims in this specification appear to cover a very wide variety of products. The general idea is that such an article as is shown in Fig. 2 should be produced from a blank of the form

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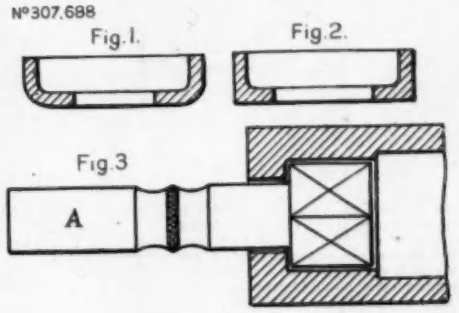
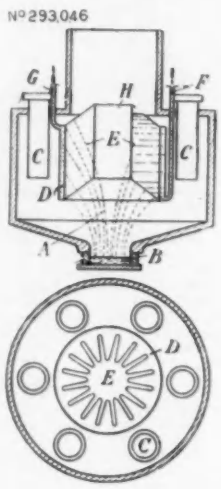


indicated in Fig. 1 by a process of rolling out the minor diameter, while the blank is held in a forming mould, so that the rounded corners are filled out to a square section. Incidentally the rolling mandrel A—see Fig. 3—is driven by a comparatively loose square coupling so that it may conform to any wear of its outboard bearing, which is not shown.—*March 14th*, 1929.

293,046. June 29th, 1928.—IMPROVEMENTS IN METAL VAPOUR RECTIFIERS, Aktiengesellschaft Brown, Boveri & Cie, of Baden, Switzerland.

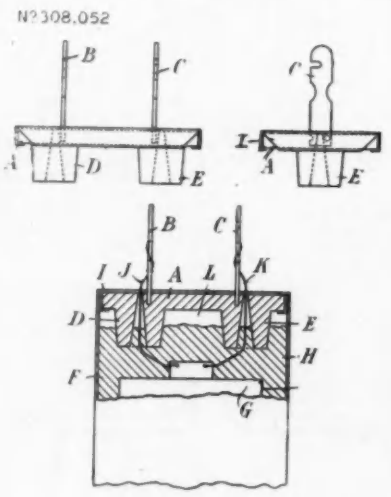
It has been found that in vapour rectifiers the mercury vapours formed at the cathode have to be kept as far as possible from the anodes. When the power is increased more mercury will, of course, be vaporised, so that the surface of the well of the metal vessel will no longer suffice for absorbing the increased lost heat. The means provided hitherto for this purpose in rectifiers of smaller power, such as anodes sleeves, &c., no longer meet the requirements which increase with the increase in power. The form of construction adopted in accordance with this invention is shown in the accompanying drawing, where A is the rectifier vessel with the cathode B and the circularly arranged anodes C. The condensation arrangements consists of a hollow body D filled with cooling liquid and having radially and inwardly directed cooling pockets E. The cooling pockets extend close up to the cylindrical outer wall of the cooling body,



leaving an unobstructed central outlet passage H. The cooling body is positional within the vessel so as to be freely accessible on all sides, so that there is communication between the anode space and the cooling dome or condensation space. The cooling pockets are longitudinally displaced in the direction of flow of the vapour with respect to the outer wall of the cooling body, so that their lower edges converge conically inwards. The cooling liquid enters at F and escapes at G. With the constructional form of the cooling body according to the invention, owing to the entire cooling surface of the cooling pockets being utilised in a suitable manner, the necessary cooling and condensation of the mercury vapour for metal rectifiers for large powers is fully realised. The brush-like stream of vapour impinges in its natural course on the surface of the cooling pockets and passes without deflection into the outlet passage. The condensed mercury collects at the lower edge of the cooling body and can be returned in a known manner to the cathode by means of separate collecting devices.—*March 21st*, 1929.

308,052. February 18th, 1928.—IMPROVEMENTS IN OR RELATING TO TERMINAL ARRANGEMENTS FOR ELECTRICAL DEVICES, The General Electric Company, Ltd., of Magnet House, Kings-way, W.C. 2, and Albert Wardle, of the Telephone Works of the General Electric Company, Ltd., Stoke, Coventry.

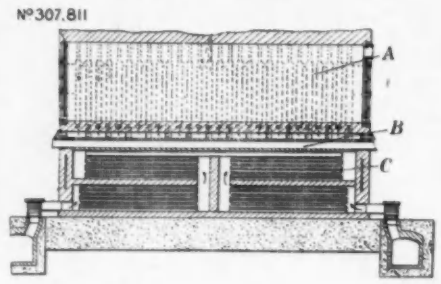
Owing to the difficulty of completely filling the container of condensers, transformers, inductances, &c., with the insulating material used for sealing and to the shrinkage which occurs when the material cools after filling, a cavity is formed within the container. Moisture originally contained in this cavity or subsequently entering owing to imperfect joints in the container tends to collect between the leading out wires and between the wires and the case, thereby deteriorating the insulation of the device. The moisture may collect on the surface of the sealing material or on the inside of the insulating block to which the terminals are attached. The object of the invention is to over-



come this trouble. A is a block of insulating material in which connection tags B and C are embedded. Projections D and E are formed on this block. At F there is a metal case which holds the condenser G embedded in insulating material H. The block A has a metal edge I secured in the case F by soldering when the top is placed in position. This is done before the insulating material H has solidified, the leading out wires J and K being threaded through holes in the block and connected to tags B and C as shown. When the top is placed in position the projections D and E enter the insulating material H, completely surrounding each leading-out wire so that no surface leakage inside the case, either between the wires or between either wire and the case can occur, even though a cavity L is left over the insulating material or is subsequently formed owing to shrinkage. No special precautions are, therefore, necessary to prevent moisture entering this space and the soldering of the metal edge I to the case need be only sufficient to hold it in position.—*March 21st*, 1929.

307,811. December 12th, 1927.—COKING RETORTS, G. Allan-Jones, Aldwych House, Aldwych, London, W.C. 2.

This invention consists in a method and means for utilising the heat of the waste gases of high temperature coke ovens for the carbonisation of coal at a lower temperature than that asso-



ciated with the high-temperature ovens. It comprises the provision of low temperature carbonising means in the regenerator space, preferably adjacent to the entrance for the hot gases. In the drawing the high temperature ovens are shown at A, the D-shaped retorts for low temperature carbonisation at B, and the regenerators at C.—*March 12th*, 1929.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy Place, Victoria Embankment, London, W.C. 2. Meter and Instrument Section. On account of the sudden death of Mr. G. D. Malcolm, Chairman of the Meter and Instrument Section of the Institution, the meeting of the Section called for to-day, has been cancelled.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Informal meeting. "London's Water," introduced by Mr. Henry Berry. 7 p.m.

JOINT MEETING OF THE INSTITUTIONS OF AUTOMOBILE ENGINEERS AND PRODUCTION ENGINEERS.—At the Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Production and Application of Ground Gears," by Mr. H. F. L. Orcutt, illustrated by cinematograph films showing gear grinding methods. 7.45 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse, "The Garden Tulip," by Sir Daniel Hall, F.R.S. 9 p.m.

SATURDAY, MAY 4TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, JUNIOR SECTION.—The fourth annual examination for the "John Wilkinson" Medal will be held at the College of Technology, Sackville-street, Manchester. 7 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Eastern District meeting at Red Lion Hotel, Cromer. 1 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Eastern District meeting at Croydon and Purley. Assemble at the Main Entrance to the Aerodrome Hotel. Discussion, "Town Planning and Municipal Air Ports," opened by Mr. Gilbert A. Ballard. 2.15 p.m.

MONDAY, MAY 6TH.

RAILWAY CLUB.—57, Fetter-lane, London, E.C. 4. "The London Extension of the Great Central Railway: A Thirty Years' Survey," by Mr. D. S. Barrie. 7.30 p.m.

SURVEYORS' INSTITUTION.—12, Great George-street, Westminster, S.W. 1. "Rights in Underground Water," by Messrs. H. F. Bidder and W. Vaux-Graham. 8 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. General meeting. 5 p.m.

TUESDAY, MAY 7TH.

INSTITUTE OF MARINE ENGINEERS.—In the Lecture Hall of the Institute, 85–88, The Minories, London, E. 1. Lecture, "Notes on the Lentz Standard Marine Engine as Fitted to Ships of the Koninklijke Paketvaart Maatschappy (Royal Packet Line), Amsterdam," by Mr. W. J. Muller. 6.30 p.m.

INSTITUTE OF METALS.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Nineteenth May Lecture, "Some Ideas About Metals," by Sir Oliver Lodge, F.R.S. 8 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. The 35th James Forrest Lecture on "Roads and Road Transport," by Sir Henry P. Maybury. 6 p.m.

WEDNESDAY, MAY 8TH.

INSTITUTE OF FUEL.—Jointly with the Institution of Chemical Engineers, in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W. 1. "The Scope of the Chemical Engineer, with Special Reference to the Boiler-house and the Fuel Industries," by Dr. S. Wolff. 6 p.m.

THURSDAY, MAY 9TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—In the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. Annual general meeting. 6 p.m.

OPTICAL SOCIETY.—Imperial College of Science and Technology, Imperial Institute-road, South Kensington, S.W. 7. The following paper will be presented and discussed, "Contributions to the History of the Spectacle Makers' Company" (second paper on the Court Collection), by Messrs. Thomas H. Court and Moritz von Rohr, with exhibits from Mr. Court's collection. 7.30 p.m.

ROYAL AERONAUTICAL SOCIETY.—In the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, London, W.C. 2 "Civil Aviation Prospects in East Africa," by Captain F. Tymms. 6.30 p.m.

FRIDAY, MAY 10TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London. Special general meeting with a view to considering and, if thought fit, passing resolutions as to a petition for a Royal Charter. 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Kenilworth Castle, Kenilworth. 10.45 a.m. Abbey Hotel, Kenilworth. Discussion on papers: "Stare Bridge," by Mr. D. H. Brown; "Kenilworth: Castle and Town," by Mr. Sholto Douglas. 5.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse "The Twist of Snail Shells," by Professor E. A. Boycott, F.R.S. 9 p.m.

SATURDAY, MAY 11TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South Wales District meeting, Swansea. 11 a.m. Council Chamber, Guildhall, Swansea. Discussion on papers: "Some Road and Other Schemes at Swansea," by Mr. Robert Hudson; "Swansea Main Drainage Scheme and Flood Relief Schemes," by Mr. J. Hassall; "Llansamlet Sewage Pumping Scheme, Swansea," by Mr. M. E. Habershon. 3.15 p.m.

TUESDAY, MAY 14TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Annual general meeting. 6 p.m.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.—Merchant Taylor's Hall, London. Annual dinner.

TUESDAY, MAY 14TH, TO OCTOBER.

NORTH-EAST COAST EXHIBITION.—Newcastle-on-Tyne.

WEDNESDAY, MAY 15TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Reform of the British Patent System," by Mr. Robert Burrell. 8 p.m.

WEDNESDAY TO THURSDAY, MAY 15TH TO 23RD.

WORLD POWER CONFERENCE.—Sectional meeting, Barcelona. Conference on complete utilisation of water power resources. For programme see page 291, March 15th, 1929.

WEDNESDAY TO FRIDAY, MAY 22ND TO 24TH.

INSTITUTION OF WATER ENGINEERS.—Birmingham. Summer general meeting. For programme see page 352, March 29th, 1929.

THURSDAY, MAY 23RD.

FARADAY SOCIETY.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, W. Annual general meeting, to read and discuss the Third (Experimental) Report to the Atmospheric Corrosion Research Committee (British Non-Ferrous Metals Research Association), presented by Mr. J. C. Hudson. 7.45 p.m.

THURSDAY TO SATURDAY, JUNE 6TH TO 15TH.

INTERNATIONAL HIGH TENSION CONFERENCE.—Paris. For provisional details see page 413, April 12th, 1929.

LAUNCHES AND TRIAL TRIPS.

THURLAND CASTLE, twin-screw cargo motor vessel; built by Cammell Laird and Co., Ltd., to the order of the Lancashire Shipping Company, Ltd.; dimensions, 460ft. by 60ft. by 31ft. 6in.; to carry cargo. Engines, single-acting reversible Diesel of Werkspoor type; constructed by North-Eastern Marine Engineering Company, Ltd.; launch, March 26th.

AZTEC, single-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of the Cuyamel Fruit Company, of New Orleans, U.S.A.; dimensions, 405ft. by 53ft. 2in. by 33ft. 6in.; to carry passengers and fruit. Engines, single set four-cylinder triple-expansion, 30½in., 51in., 62in., 62in. by 48in. stroke, pressure 200 lb. per square inch; constructed by the builders; trial trip, March 28th.

ULSTER QUEEN, twin-screw motor vessel; built by Harland and Wolff, Ltd., to the order of Belfast Steam Ship Company, Ltd.; dimensions, 345ft. by 46ft. by 19ft.; to carry passengers. Engines, two ten-cylinder airless-injection trunk-type Diesel engines of the Harland-B. and W. type; constructed by the builders; launch, March 28th.

SARNIADOC, single-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of Paterson Steamships, Ltd., Fort William, Ontario, Canada; dimensions, 259ft. by 43ft. 4in. by 20ft.; to carry cargo. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; trial trip, March 30th.

ASNI, single-screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Compagnie de Navigation Paquet; dimensions, 340ft. by 43ft.; to carry passengers and about 3000 tons. Engines, triple-expansion; constructed by the builders; a speed of about 14¼ knots was attained on trial trip recently.

STANASFALT, single-screw steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of the Standard Shipping Company; to carry 2000 tons liquid asphalt; trial trip, April 4th.

COTEAUDOC, single-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of Paterson Steamships, Ltd., Fort William, Ontario, Canada; dimensions, 259ft. by 43ft. 4in. by 20ft.; to carry cargo. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; trial trip, April 5th.

SIOUX, single-deck screw steamer; built by Barclay, Curle and Co., Ltd., to the order of St. Lawrence Steamships, Ltd.; dimensions, 259ft. by 43ft. 2in. by 20ft.; 2585 tons. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; launch, April 6th.

IRANIA, oil tanker; built by Blythswood Shipbuilding Company, Ltd., to the order of Iranian Tanker Company, Ltd.; dimensions, 300ft. by 44ft. by 20ft.; to carry oil in bulk. Engines, 1250 S.H.P. three-cylinder double-acting two-stroke, 21¼in. bore, 38in. stroke; constructed by Richardsons, Westgarth and Co., Ltd.; trial trip, April 8th.

HIGHLAND PRINCESS, motor vessel; built by Harland and Wolff, Ltd., to the order of H. and W. Nelson, Ltd.; dimensions, 520ft. by 69ft. by 35ft. 9in.; to carry passengers and cargo. Engines, two eight-cylinder double-acting four-cycle motor engines; constructed by the builders; launch, April 11th.

ALGONQUINO, single-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of St. Lawrence Steamships, Ltd., Welland, Ontario, Canada; dimensions, 259ft. by 43ft. 4in. by 20ft. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; trial trip, April 15th.

TARPON, steamship; built by Ferguson Bros. (Port-Glasgow) Ltd., to the order of Crown Agents for the Colonies; dimensions, 150ft. by 30ft. by 9ft.; to carry passengers in British Guiana. Engines, pressure 150 lb. per square inch; constructed by the builders; a mean speed of 11½ knots was attained on trial trip, April 17th.